Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVIII. JANUARY, 1925 No. 1

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Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—State Hwy. Commission let contract for 4 roads: Lowndes Co. grade and gravel 15 miles rd. from Montgomery Co. line to Fort Deposit, via Davenport, to Ned Giddens, Troy, at $214,430—grade and gravel; Buchanan, Champanois & Blanks, Meridian, Miss., at $21,403 for ridges; Monroe Co. grade and gravel 9.125 miles betw. Monroeville and Camden to Ned Giddens, at $86,288 for grading and graveling; J. H. Bull, Winfield, $19,190 for bridges; Hale County, 12.6 miles gravel betw. Greensboro and Wedgeworth to E. L. Ellis, Gainesville, at $94,855; Lauderdale Co. 7.16 miles paved and chert surf. betw. Florence and Killen, to Uvalde Paving Co. Dallas, at $199.524.

Ark., Lonore—Keliher Constr. Co., Southern Trust Bldg., Little Rock, awarded contract for 4 miles Missouri-Ark. Hwy., at $108,000; 8-ft. conc. with 4-ft. wide dirt shoulders on either side.

Ark., Seale—J. W. Gwin, Hamilton Sta., Birmingham, awarded contract by State Hwy. Comn. to gravel surf. 17.85 miles in Russell Co.—Hurtsboro to Seale—at $129,549.

Cal., Bakersfield—Union Paving Co., 620 Call Bldg., San Francisco, awarded contract for impvt. of 24th St.—M St. to Union Ave.—in Dist. 503—at $60,428. Work involves 1½-in. Warrenite pavement on 3½ inch asphalt concrete base.

Cal., Blythe—Pearson & Dickerson, Riverside, awarded contr. to pave Hobsonway—Main St. to west City limits—at $53,239. Work involves grading, conc. paving, etc.

Cal., Inglewood—Geo. R. Curtis Paving Co., 2440 E. 26th St., Los Angeles, awarded contract for paving in Arbor Vitae St.—Market to Kenwood Sts.—at $49,037.

Cal., Los Angeles—Jas. Martin, 789 Lyon St., awarded contract for impvt. of Hawthorn Ave.—Riverside Blvd. to Rodondo-Torrance Blvd.; 13,400 ft. or 2.54 involving 8-in. and 9-in. conc. pavement; disint. granite shoulders, etc.; W. D. McCray, 416 American Bank Bldg., awarded contract for conc. pavement, curb, walk, gutter, cement sewer, ornam. lights, etc., at $46,025.

Cal., Los Angeles—J. J. Akmadzich, 821 Yale St., awarded contract for curbs, walks, gutters, oiling, rolling, etc., at $6,068 on portion of West View Ave., Griffith Co., 502 L. A. Ry. Bldg., contract for cem. conc. pavement, a sph. pavement, curbs, etc., on portion of 15th St., at $16,647; C. E. Crowley, 601 Pacific Elec. Bldg., contract for impvt. of Western Ave.—East line of Palos Verdes Est. to w. line Tr. 4252 at $9,548; Griffith Co. also awarded contract for cem. conc. pavement in Ocean Ave.—50-ft. n. e. of Mrmon St. and 50-ft. s. w. of Harris Pl:—at $10,248; W. D. McCray, 416 American Bank Bldg., awarded contract for cem. conc. pave., curb, walk, sewer,, etc. in Canal Ave.—S to L Sts.—at $11,577; O. W. Fisher & Son, 1332 Myrtle, Long Beach, awarded contract for impvt. of alley no. of Anaheim St. east from Olive Ave., at 22.9c sq. ft. for pavement, 50c ft. curb, 20c sq. ft. walk, 75c ft. curb armor. Los Angeles County let followng contracts for road work: Griffith Co. L. A. Ry. Bldg., contract for impvt. of 62nd—Compton to Hooper Aves.—at $9,688 and 61st—Compton to Hooper Aves.—at $9,334; E. L. Phillips, 109 La Paloma Ave. Alhambra, contract for Towne Ave. 94th, 95th and other thoroughfares, at $2,272, also Alpha Ave.—Woodbine to w. cor. Tr. 7265, at $5,815: Fry Bros. Contr. Co., 2905 Eliot St., Long Beach, awarded contract for impvt. of Ford St.—Eugene Ave. to Anaheim-Telegraph Rd.—at $70,113; Geo. H. Oswald, 366 E. 58th St., Fir. St.—Manchester to Shorb Aves.—at $19,668; also Elm St.—Manchester to Shorb Aves.—at $20,436.

Cal., Los Angeles—Chalmers & Ford, 532 H. W. Hellman Bldg., award contract by Bd. Pub. Wks. for cem. conc. pavement, etc., at $43,361.

Cal., Los Angeles—T. W. Oglesby, 423 Edgewood Rd., Santa Ana, award. contract by County for impvt. of Durfee Ave.—Pomona Blvd. to Lexington-Gallatin Rd.—at $44,757; 16,030 ft. or 304 miles under RDI No. 254, involving concrete pavement; Allied Construction Co., 459 E. Third St., awarded

STEAM KEYSTONE SHOVELS

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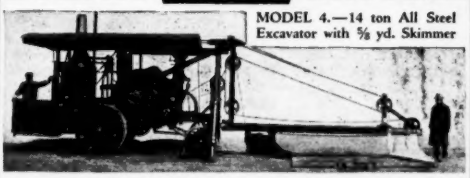

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The KEYSTONE is a highly versatile traction steam shovel with all the efficiency of specialized design, usable with three different interchangeable scoops—*Skimmer, Ditcher and Clam Shell*—for Road Grading, Trenching, Back-Filling, Cellar Digging, Pit Mining, Loading, Unloading and Handling Materials. Can be equipped with electric motor drive for use in buildings. Saves first cost, moving cost and upkeep and is readily sold or rented for any sort of excavation job. A reliable road shovel of remarkable adaptability to other uses.

The heavy Keystone Skimmer Bucket, ⅝ yd. capacity, has a horizontal crowd of 14 feet and fills itself at one shot in a six inch cut. It leaves a smooth surface, finished to grade and thus dispenses with costly hand-trimming. Shallow digging on hard material—old macadam, paving blocks, concrete and asphalt—is keystone work.
Made in two sizes: Model 3, 10 ton and Model 4, 14 ton. The good Keystone Digging Ideas in our catalogs and advertising sheets have made money for 1500 Contractors in the United States. Ask for them.

Model 4, with Boom extension and ½ yd. Clam Shell Bucket

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D-4

CUMMER ASPHALT PLANTS

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Four Sizes, 750, 1250, 1800 and 2000 square yards 2-inch top per day.

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Capacity 2000 square yards 2-inch top daily.

Over 300 plants in successful operation.

Cummer plants never wait for hot sand.

Prompt Shipment on All Plants.

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street contracts by Board of Public Works as follows: 37th St.—Carolina to Laffey Sts.—at $10,595; Vermont Ave.—Adams St. to Slauson Ave.—at $16,342.

Cal., Lynwood—Hall-Johnson Co., 3025 Fowler St., Los Angeles, awarded contract by City for oil macadam pavement, etc., in Lynwood Rd. and other thoroughfares, at $40,828.

Cal., Santa Ana—Griffith Co., 502 L. A. Ry. Bldg., Los Angeles, contract for approx. 1.9 miles 6-in. conc. pavement in Santa Ana Canyon Blvd., at $49,757.

Cal., Santa Barbara—Jas. T. Cornwall, 343 Pleasant St., Santa Barbara, awarded contrct by City to pave on De la Guerra St., at $45,154.

Cal., Santa Monica—Keene Paving Co., 216 Durley Blk., Santa Monica, awarded contract to pave Montana Ave.—7th to 26th Sts.—at $107,255. Involves 408,407.48 sq. ft. grad.; 408,407.48 sq. ft. bitulitic pavement on asph. conc. base; curb, water system complete at $2,900. 10 manholes to grade, etc.

Cal., San Marino—J. E. Haddock, 357 N. Chester St., Pasadena, awarded contract for impvt. of Huntington Dr.—Granada to Rose Aves.

Cal., Signal Hill—Geo. R. Curtis Paving Co., 2440 E. 26th St., Los Angeles awarded contract for impvt. of Burnett Cherry, Orange and other streets, at $68,220. Involves 2-in. Willite pave. on 4-in. asph. conc.

La., Baton Rouge—Graveling 8 miles Secs. E. and F Greensburg-Clinton Hwy., State Proj. 369, St. Helena Parish, to Kentwood Gravel Co., Kentwood, at $70,235; also 5 miles State Proj. 418A, Jennings-Lake Arthur Rd. to Fox Lumber Co., Lake Arthur, at $5,300.

Fla., Arcadia—Wm. P. McDonald Constr. Co., Lakeland, awarded contract by De Soto County Commrs. for 118 miles hard surf. roads; Florida limerock base, with Tarvia, asphalt and slag surf. treatment, at $1,025,571.

Fla., Fort Meade—J. H. Pryor & Deen, Ft. Meade, awarded contract for about 40,000 sq. yds. Findlay penetration macadam street pavement, at $52,560.

Fla., Jacksonville—Morgan-Hill Paving Co., Graham Bldg., Jacksonville, awarded contract by Murray Hill Development Co., at $140,000, for 5½ to 6 miles paving in Murray Hill subdiv., at $140,000.

Fla., Punta Gorda—Jas. G. Yeates Co., Citrus Exchange Bldg., Tampa, Fla., award. contract to pave streets with vertical fibre brick; asphalt filler, etc., at $110,000.

Ga., Atlanta—MacDougald Constr. Co., 180½ Spring St., award. contract for paving 45,748 sq. yds. Ponce De Leon Ave., at $134,613; 2,909 sq. yds. Weyman Ave., at $9,307. 960 sq. yds. Emery St. at $2,534; Jamison & Hallowell, Candler Bldg., 2,501 sq. yds. Bonlerara De Kalb St., at $6,603; 3,410 sq. yds. Byron Dr., $9,002; 2,376 sq. yds. Winslow St., $6,273, 3,409 sq. yds. Ashland Ave., $6,562, 2,556 sq. yds. Hale St., $5,690, to Case & Cothran, Candler Bldg., 2,881 sq. yds. Lee St. $6,750; 1,576 sq. yds. Brownhead Ave., $4,161, to Meader Constr. Co., 10 West Harrison St., 1,760 sq. yds. North Ave., at $3,388, to S. E. Finley Co., Atlanta, Main and Market Sts., Cartersville, at $7,500—all contracts let by Fulton County.

Ga., East Point—State Hwy. Dept., East Point, let contracts for 4 roads as follows: Jones Co. 10.456 mi. top soil to J. R. and J. B. Miller, Baconton, at $77,901; Gordon Co. conc. and steel bridge and approaches over Oostanula River on Calhoun-Dalton Rd. to same contractors, at $62,929, and Va. Bridge & Iron Co., Madison Ave, N. E., Roanoke, Va., at $12,320; Wayne Co., 7.298 mi. sand clay Baxter-Jessup rd. to Bryson Paving Co., Jacksonville, Fla., at $54.281, and at $6,070 for timber bridge; Lowndes Co., 2 bridges and culverts on Valdosta-Quitman rd. to Bryson Paving Co., at $33,274; Taylor Co. 4.442 mi. sand clay, Butler-Thomaston, to Scott-Chambers Co., W. Point, at $24,329; Bartow Co. 1.623 mi. penetration macadam Cartersville-Calhoun, to S. E. Finley, 212 W. North Ave., Atlanta, at $36,160.

Ill., Johnson City—Holland Constr. Co., Marion, awarded contract for Paving Dist. 4, includes 5th and 7th Sts. in business dist. and streets adjoining. Bid price, $48,789.91.

Kans., Washington—Cook Constr. Co., Otawa, Kansas, awarded contract for grading 11 mi'es from pt. 2 miles no. of Morrowville west thru Haddam to W. line Washington Co.; 6 big conc. bridges to Wayland Bridge Co., Washington; 20 small bridges to Interstate Bridge Co., Fairbury, Neb.—about $125,000.

Mo., Cape Girardeau—Cocke & Turner, Marshall, awarded contract by City Comn., to pave 10 streets with 3-in brk. on 4-in. conc. base, at $145,025.

Mo., Centralia—Fry Brothers Constr. Co., Iola, Kansas, award. contract for 13 blocks of paving, at $41,300.

Mich., Grand Traverse—J. R. Edelman, Muskegon, awarded contract by State Hwy. Comn., at office Commrs. Grand Traverse Co. here, for grading and concrete surfacing 5.439 miles FAP 129-C, at $158,628; St. Hwy. Dept., Lansing, will grade and conc. pave 4.382 miles F. A. P. 95, A-3, Washtenaw and Lenawee Cos. by Day Labor. $145,364.

Mo., Jefferson City—Arthur A. Dobson Co., 809 1st Nat'l, Lincoln, Neb., contract for labor for abt. 15 miles concrete State rds., Carroll and Cass Cos., at about $250,000. State purchases materials—abt. $500,000.

Mich., Lansing—State Trunk Line contracts let as follows: Rd., 91-1, Menominee Co., Ingallston Twp., 2 culverts, to Mike Aman, Daggett, Mich., at $2,133; Mich. Fed. Aid contracts let as follows: Jno. R. Edelman, Muskegon, Mich., contract for Rd. F. A. 129, C, (T. L. 11) Grand Traverse Co., Blair and Garfield Twps. Cl. 7-in. 7 Std., 20-ft. wide, 5.439 miles, at $113,032; Assessment Dist. contracts: Rd. A. D. 445-A, Lapeer and Mussey Twps. Cl. G and DS, 0.300 miles to Port Huron Sand and Gravel Co. Pt., Huron, Mich., at $12,665.

Nev., Carson City—Nevada Contg. Co., Fallon, awarded contract by State Hwy. Comn. for grading and gravel surfacing 16.02 miles road betw. west and east slope of Mormon Mesa, FAP 52, Contr. 116, Clark 6-G, at $90,533.

N. Y., Brooklyn—Following impvt. contracts let by F. Riegelmann, Boro. Pres.: R. Lynster, 1364 Sterling Pl., grading, curbing, Cortelyou Rd., at $2,796; Galco Contg. Co., 745 Dean St., E. 9th St. $3,927, E. 34th St. $2,037, to F. Mersicano, 350 Fulton St., E. 14th St. $4,411; M. J. O'Hara, 1228 Park Ave., N. Y. C., asph. paving Gelston Ave., at $12,461; Kenmore Pl. $10,552; Ave. P, $54,416; Quentin Rd $8,803, 56th St. $9,793; 62nd St. $10,465; Borough Asphalt Co., 1301 Metropolitan Ave., Montgomery St. $9,920; Cranford Co., 52 Ninth St., 85th St. $7,939; Liberty Ave., $146,459.

N. Car., Ahoskie—Atlantic Bitulithic Co., Washington, N. Car., awarded contract by Board of Commrs. to pave Main Street with concrete and asphalt comb., at $53,539.

N. C., Raleigh—State Hwy. Comn let contracts for 13 roads as follows: Lincoln Co. 2 secs.—9.88 mi. asphalt to P. R. Ashby, 421 N. Pearson St. Raleigh, at $194.265; 5.03 mi. asph., to same contractor, at $106,625; Swain County, 6.81 mi. grading to Discus Bros., Waynesville, at $53.120; structs. to E. A. Wood, Andrews, at $19,308; Haywood Co., 9.89 mi. grading to Discus Bros., at $113.426; structs. to Booze Boyd & Co., $23,533; Yadkin Co., 6.29 mi. grading to W. A. Graham, at $52,744; structs. to Hagedorn Constr. Co., Commerce, Ga., at $21.527; Stokes Co., 2.37 mi. to C. A. Helig, W. Highlands, Winston-Salem, $13,396; Wake Co., 5.42 mi. grading to C. B. Hester, at $25,703; structs. to Booze Boyd & Co. $25,195; Harnett Co., 3.62 mi. grading to J. S. Morrow, at $27,529; Franklin Co., 2.84 mi. grading to J. A. Morrow, Clarksville, Va., at $20,816; New Hanover Co., 7.59 mi. grading to J. F. Mulligan, at $51.496; structs. to Atlantic Bridge Co., at $47,683; Hertford Co., grading to Ray James, at $52.060; structs. to Atlantic Bridge Co., at $58,630; Halifax Co., 15.31 mi. topsoil to Nello L. Teer Co., Durham, at $72.371; structs. to J. J. Bowers, at $12,356; Henderson Co., 6.97 mi. waterbound macadam to C. M. Discus, Waynesville, at $138,975; also 3 bridges: Craven County, over James River, Robert W. Curtis, Lynchburg, at $25.666; Chatham-Lee Cos. over Deep River, Atlantic Bridge Co., at $68,006; Wilkes Co., over Reddies River, tto Atlantic Bridge Co., at $12.582.

Okla., Oklahoma City—City let contracts for 5 roads and 9 bridges: Pittsburgh Co., 3 sections: Proj. 120-C, conc. rd. to Altman & Rogers, McAlester; Proj. 186, grading, Pharoah Bros. & Sharp, Okeman, abt., $20,000; Proj. 88, Sec. A, shale rd. to J. G. Newkirk; Wagoner Co., 1½ mi. gravel rd. to Maney Bros., Oklahoma City; Seminole Co. grading to Maney Bros., Pittsburg Co., 3 bridges; Proj

20-B, Gaines, Keokum & McKay, Okla. City, $64,000; 120-B, underpass, Ben. Flynn, Newkirk, $7,000; 88, Sec. B, D. S. Miser, Rosedale; Beaver Co., 6 bridges, Kidough Bros., Chandler.

S. D., Pierre,—Cummings & Mistelske, Vorgas, Minn., awarded contract for grading 4.81 miles F. A. Proj. 130, Custer Co.; 15,000 c. y. solid rock excav., $1.90 per c. y.; 5,000 c. y. loose rock excav., 75c; 25,481 c. y. com. excav., 28c; 245 lin. ft. log bridge, $8; 2,880 sq. ft. end cribbing, 25c—total $43,796.

Tex., Albany—Crouch & Nolan, Strawn, awarded contract for concrete work in Shackleford Co., at $84,766; Nelson & Van Ehman, Cisco and Clifton Sts., awarded contract for earth work on 15.55 mi. State Hwy. No. 23, Albany-Moran Rd., at $40,887.

Tex., Alice—H. J. Evans, 600 W. 15th St., Austin, awarded contract for grading 5.65 miles State Hwy. 12-A, at $6,883; bridge constr. to Armstrong & Armstrong, Roswell, N. M.; grade and bridges on 16.10 miles hwy. 12, to same contractors at $93,389; grade 14.42 miles State Hwy. 12 to D. H. Buchanan & Son, Temple, at $25,906; bridges to Armstrong & Armstrong, at $35,205.

Tex., Carthage—Tibbetts Constr. Co., Mineral Wells, and J. S. Moore & Son, Lufkin, awarded contract to grade and construct bridges on State Hwys. 8 and 64m, totalling 21.47 miles, at $136,000 (Panola Co.).

Tex., El Paso—El Paso Bitulithic Co., 160 N. Piedras St., contract by El Paso Co. Commrs., at $78,336 to widen and resurf. road from Ysleta to Socorro.

Tex., El Paso—Orr & Wright, awarded contract by El Paso Co. Commrs., at $140,028, for 7.35 mi. Kern Pl. Rd., State Hwy. No. 1—El Paso to White Spur, at $140,028.

Tex., Greenville—J. A. Block & Co., W. 8th St., Ft. Worth, awarded contract by Hunt Co. for 13 miles waterbound macadam with asphalt topping on city road from point north of here to Fannin Co. line, thru Wolf City, at $73,055.

Tex., Houston—Gulf Bitulithic Co., 701 Foster Bldg., Houston, awarded contract to pave Blodgett Ave. with 2-in. Warrenite-bitulithic, at $56,050; Smith Bros., American National Bank Bldg., Dallas, awarded contract to pave Heiner and Sabine Sts. with 2-in. asphaltic concrete, at $42,863.

Tex., Jacksboro—Hayden & Austin Constr Co., Houston, awarded contract by Jack Co. Commrs. to lay macadam base with asphalt topping on 3 sections of roads: 16.68 miles State Hwy. 24, Graham Rd.; 17.38 miles State Hwy. 39, Decatur Rd.; 10.94 miles State Hwy. 24, Mineral Wells Rd., at $637,948.

Tex., Jefferson—Tibbetts Constr. Co., Mineral Wells, awarded contract by Marion County for 20.55 miles Amiesite paving on State Hwy. 49, at $171,177.

Tex., Marshall—Cocke & Turner, Marshall, awarded contract to pave with 3-in. brick on 4-in. concrete base, 10 streets, or sections of streets, at $103,239.

SEWERAGE AND SEWAGE TREATMENT

Cal., Laguna Beach—A. Giebisch, Virgil Walk, Long Beach, awarded contract for sewer laterals, disp. plant, etc., at $70,761; sewer lat. sys., $45,667; pumping station, $9,809; disp. plant, $11,085; ocean outfall, $4,200.

Cal., Los Angeles—Adam Dalmatin, 841 W. 62nd St., awarded contr. by Bd. Pub. Wks. for sewer comp. in Colorado Blvd.-Maywood Ave. to W. City limits—at $166,000.

Cal., Riverside—Pernel Barnet, 630 E. Washington St., Orange and Olivarri Contr. Co., 107 S. Main St., Santa Ana, awarded contract by city at $57,012.48 for sewer in portion of Van Buren St.

Fla., Punta Gorda—I. C. Michler, Daytona Beach, awarded contract for storm and sanitary sewers in various sts., at $133,199.

Ga., Macon—J. B. McCrary Engrg. Corp., Citizens & Southern Bank Bldg., Atlanta, Ga., awarded contract for laying sewers for Cherokee Hts. outfall sys. and bldg. disposal plant; also laying sewers on Water St., E. Mason, at $32,257.

Ill., Pana—W. G. Trayer Co., Decatur, Ill., awarded contract by Bd. Pub. Impvts. for north and east sanitary sewer and outlet treating plant, at $99,679.

Ia., Dubuque—Uhlrich-Paley Constr. Co., Dubuque, awarded contract for san. sewerage system on Southern Ave., S. Grandview Ave., etc., at $59,132.

La., Oakdale—James Contg. Co., Shreveport, awarded contract for constr. of sewerage system. Engineer's est. $35,000.

Md., Baltimore—Consolidated Engrg. Co., Calvert Bldg., awarded contract for storm drain in Gwynn's Run—Baltimore to Lexington Sts., at $45,086 and at $29,788 for new screen house at Back River sewage disp. works; D. C. McAleer Constr. Co., Phoenix Bldg., for storm water drain in Glen Ave. and Clover Rd. section, at $31,991; Catalano & Picora Constr. Co., Knickerbocker Bldg., Baltimore, awarded contract by Baltimore Co., Commrs. for sewers and appurts. in Catonsville and Colgate, Proposal 1-S, at $91,025.

Mich., Detroit—Liberty Constr. Co., 1026 Dime Bank Bldg., contr. for constr. of lat. sewer 4228, at $128,922; Mich. Constr. Co., 400 Penobscot Bldg., lat. sewer 4230, at $3,070; S. Healy, 6466 Epworth Blvd., lat. sewer, 4242, $18,127; lat. sewer 4258, $5,294; J. Leo, 1762 Puritan Ave., lat. sewer 4855, $495; C. R. Lennane Co., 2631 Woodward Ave., lat. 4256, $14,371; A. Rossi, 1337 Brady St., lat. 4247, $12,847.

Mich., Grand Rapids—Vander Weele Bros., Grand Rapids, awarded contr. for constr. of Silver Creek Drain, Contr. K-1, at $237,693.

Mich., Jackson—Rennie & Dibble, 11565 Oakwood Ave., Detroit, awarded contract for constr. of West Side intercepting sewer, 1,600 ft. 54-in., 1,950 ft. 48-in., 5,200 ft. 24-in., 4,640 ft. 20-in. and 900 ft. 10-in. cast iron pipe, at $117,645.

N. Y., Long Island City—J. H. Johnson, awarded contract for sewer in 95th St., at $40,586; sewer in 95th St., $10,373; temp. san. sewer in Breckenridge Ave. and reconstr. of outlet on Remsen St. sewer to J. Gallo, 203 Division St., Brooklyn, at $16,208 and $3,735 respectively.

N. Y., New York—Slach & Slach, 146 Montague St., Brooklyn, contract for sewers in Edison Ave., at $11,422; Bronx Sewer Constr. Co., 375 E. Fordham Rd., contract for Intervale Ave. sewer, at $417,055.

N. Y., St. George—Hammen & Co., 279 Madison Ave., Perth Amboy, awarded contract for temp. sewers in New Dorp, Oakwood and vicinity, at $224,970.

Ohio, Cleveland—Salem & George Bros., Erie Bldg., awarded contr. for 3,500 ft. 3 ft. 6-in. to 4-ft. 6-in. conc. sewer in Sections 8 and 9, Southwest Sewer Dist., at $86,462.

Va., Westhampton—R. Sta. Richmond, Cheatwood & Driscoll, Vawter Ave. and Highland St., Richmond, awarded contract for constr. of sewerage and draining system for suburban residences, at $38,000.

Wis., Milwaukee—Chain Belt Co., 736 Park St., awarded contract by Sewerage Comn., for conveyor system in filter and dryer house at Jones Island, at $91,400.

WATER SUPPLY AND PURIFICATION

Ark., Gurdon—Hayden Construction Co., Jackson, Miss., awarded contract for constr. of water and sewer systems for Gurdon, at $102,197; Pittsburgh-Des Moines Steel Co., awarded contract for tank and foundations, at $5,200.

Cal., El Centro—Following awards made by city for water works material and equipment: De Laval Steam Turbine Co., pumping machy., at $12,945; Crane Co., valves, at $2,425; Cl. A lead pipe to Crane Co., at $1,836; Cast iron pipe to Am. Cast Iron Pipe Co., at $40,103 and cast iron fittings, at $2,135; pig lead and oakum to Machine Pipe & Supply Co., at $4,382; fire hydrants to Water Works Supply Co., at $3,170; corp. and curb cocks, at $437; Hartley-Camp Constr. Co., laying mains, etc., at $22,229.

Ont., Ford—Border Utilities Commission let contract for pumping station to Windsor Constr. Co., 8 Condon St., E. Windsor, at $87,414; laying intake pipe to Considine Reid Co., Ferry Docks, Windsor, at $18,500; intake tunnel to Merlo, Merlo & Ray, Ford, at $22,700; valves to Francis Hankin Co., 20 St. Nicholas St., Montreal, Que., at $4,500; float regulators to International Filter Co., Toronto, at

$1,700; screen to Link Belt Co., Chicago, Ill., at $6,930; steel intake pipe to Horton Steel Co., Bridgeburg, at $10,228; pumping equipt. to Turbine Equipment Co., 73 King St., W., Toronto, at $28,495.

N. Y., Long Island City—Norton & Rigney, Richmond Hill, awarded contract for mains in Anable, Vandeventer and 9th Aves., etc., here, at $38,000; also mains in Manley St. to S. Gallucci, Railroad Ave., Corona, at $18,299.

Mich., Clawson—J. A. McDace Co., 1992 Webb Ave., Detroit, awarded contract for constr. of 17,200 ft. 8-in. and 26,500 ft. 6-in. cast iron mains, etc., at $79,883; R. D. Baker, 1631 Elmhurst Ave., Detroit, awarded contract for 717 ft. 10-in., 5,010 ft. 12-in., 740 ft. 18-in. and 805 ft. 20-in. sewers, etc., at $15,570.

N. Y., New York—Norton Engineering Co., 510 W. 149th St., awarded contract for mains in Baychester, Doller, Hunter, Leggett, Palmer and Randall Aves., etc., at $38,584; Beaver Eng. & Contg. Co., 57 Chambers St., awarded contract for transferring taps, etc., to mains in various streets, at $7,012; Norton Engrg. & Contg. Co., 510 W. 149th St., also awarded contract for mains in Arlington, Fairfield, Claflin, Davison, Longwood, Netherland Aves., etc., at $10,435.

Ohio, Barberton—Carmichael Constr. Co., 524 Central Savings and Trust Bldg., Akron, awarded contract for filter plant constr., pumping station, sedimentation and clear water basin, low service piping, etc., at $160,000; furnishing pumps, heating, plumbing, filter and electrical equipt., to Pitt Construction Co., Fulton Bldg., at $75,000; furnishing pipe to J. B. Clow Co., 544 S. Franklin St., Chicago, Ill., at $129,372; furnishing valves to Pittsburgh-Des Moines Steel Co., Curry Bldg., Pittsburgh, Pa., at $25,996.

Ohio, Cleveland—F. Hadded, Davis & Farley Bldg., awarded contr. for 16,000 ft. 6 and 8-in. cast iron mains in impvt. 66, at $64,000.

Okla., Clinton—Allied Contractors, Omaha, awarded contract at approx. $80,000, for water works impvts. here.

Okla., Oklahoma City—Boardman & Co., W. Maple St., awarded contract for new inlet works for reservoir at 39th St., including conc. top for dike gates, control tower, 14,000 sq. yds. riprap, 7,700 c. y. conc., 31,000 c. y. excav., at $167,010.

Ore., St. Helens—Coast Culvert & Flume Co., Portland, awarded contract to furnish about 4 mi. 12 and 14-in. steel pipe for new water system at $38,000; A. Compton, McMinnville, awarded cont. by Commrs. for 2,000,000 gal. conc. reservoir, at $30,687.

R. I., Providence—Cenedella & Co., School St., Milford, awarded contract by Water Board for about 1 mile of 7.5 ft. circular rein. conc. aqueduct and appurts., at $298,470.

Tenn., Jackson—Pittsburgh-Des Moines Steel Co., Praetorian Bldg., Dallas, Tex., awarded cont. for constr. of 46x85 ft. steel tower, at abt. $20,500.

Wash., Lowell—H. W. Troutman, 15 W. Prospect St., Seattle, awarded contract by City Council for constr. of water works, at $23,580.

Wash., Seattle—J. L. Smith, awarded contract for excav. of trench, hauling, laying and riveting 54-in. lock bar pipe in Cedar River pipe line No. 2, 20th Ave. et al., at $54,914; Argentieri & Co., awarded contract for water mains on E. 53rd St., et al., at $3,254; Felix Arcorace, contract for water mains in 14th Ave. N. E., at $4,271.

Prospective Work

ROADS AND STREETS

Ala., Mobile—City Comn. plans to resurface with sheet asph. on 6-in. base, 4 streets in business dist.

Arizona—Fed. Aid Proj.: Arizona Proj. No. 84, Maricopa and Yacapai counties; 31.6 miles, appvd. Est. cost $825,000.

California—Fed. Aid Proj.: No. 41, Shasta Co.: 49.03 miles approved. Est. cost $3,500,000.

Cal., Los Angeles—City has retained D. L. Reaburn as Cons. Engr. for constr. of new $1,000,000 Beverly Blvd. impvt. to the ocean. Representatives of Rosemead and other communities, are conferring with County Regional Commission (Hugh Pomeroy, Secy.), for 9 mi. hwy. thru Rosemead from ft. hills to Pico and Rosemead Ave., providing new through blvd. to Long Beach. Improvement of Gaffey St. (exten. proj.) as additional entrance hwy. to San Pedro, under consideration as one of first hwy. impvts. to be done under recent $5,000,000 bond issue. Petition for work in hands of Major Traffic Commission. Plans for new hwy. betw. Los Angeles and Santa Ana, paralleling Pac. Elec. tracks, submitted to Co. Reg. Planning Comn. Prelim. survey made by L. H. Compson, Flood Div. Engr. of Comn. Proposed road would be 27 miles of 100-ft. blvd. with paved rdway of from 20 to 40 ft. in width.

Cal., Pomona—City Engr. F. C. Froehde has started survey for pavement on W. 5th St. Conc. pave., curb to curb. This is one of the largest jobs to be done under the $400,000 street pavement program.

D. C., Washington—Dist. Commrs. plan to widen Park Rd. betw. 13th and 16th Sts. Est. cost $350,000.

Fla., Bradentown—Manatee County Commrs. plan to build 3 roads: 37¾ miles to Arcadia connecting at Griffin St., Manatee, with De Soto Co. line, $547,104; 23 miles east from Parish to connect with Hardee and Polk Co. line, including spur to Albriton School—both projects to cost $552,870. Will vote in January on bonds. F. K. Webb, Co. Engr.

Fla., Key West—Election in January or February to vote on $1,000,000 bonds for additional road bldg. in Monroe Co., Key section.

Fla., Orlando—J. W. Young, Pres. Hollywood Land & Water Co., Hollywood, reported to build 7 miles of road on Sebring-Palm Beach Rte. to connect hard surf. road so. of Sebring with Conner's Hwy.

Fla., Orlando—City plans to pave or widen 75 streets; will vote this week on $430,000 bonds. City Engr. Mr. Matthews.

Fla., Tampa—Hillsborough Co., Palm River section, plans to build 5 miles of road from Hillsborough Bay nr. mouth of Palm River, to Limona rd. crossing Bayshore and Riverview roads. Plans creating bond dist., including 1 mile betw. boundaries of each and northeast Tampa districts. Contemplate $160,000 bond issue. J. A. Mortland, Cons. Engr. for district.

Ga., Atlanta—City plans to expend about $118,549 to pave 13 streets, including Hardee, Harwell and Hogue.

Fla., W. Palm Beach—Palm County Commrs. plan to build and improve 7 roads in Special Rd. and Bridge Dist. 11: 69.4 miles Belle Glade to Henry Co. line, $393,000; 10 miles Belle Glade to Pahokee, $232,000; Choson to Pelican Bay, $121,800; Choson to Pahokee, $98,860; Canal Point to Bacom's Point, $149,000; road south, west and north from Belle Glade thru Okeelanta and Gardenia to lake shore near Henry Co. line, $319,000; repair and oil Belle Glade-Chosen Rd., $13,000; build lesser roads, improve military trail and roads west of Delray and other thoroughfares; also plans expending $70,000 for bridges—all impvts. contingent upon $1,800,000 bond issue..

Ill., Chicago—Brainerd Impvt. Assn. successful in getting County Court to confirm order for paving of streets in Bishop St. system including Justine, Laflin and Bishop from 83rd to 87th, and 83rd, 84th, 85th, 86th and 87th Sts. betw. Loomis and Ashland Ave. City Council will act on petition of Northcenter Commercial Assn., for widening and improving Robey St. and Irving Park Blvd. There is also an attempt being made to have Northwestern railroad tunneled at Byron St. to form uninterrupted passage to Lincoln Ave. Impvts. on 15th Ward streets ordered by City Council. These will include paving with asphalt 56th—Western to Rockwell Sts. and Hamlin Ave. —55th to 59th Sts.

Ky., Somerset—$135,000 bonds voted by city for street and sewer impvts. C. B. Cundiff, City Clk.

La., Baton Rouge—East Baton Rouge plans graveled and hard surf. roads, including Parish's portion of Highland Rd. to New La. State University. $360,000 bonds will be issued.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Kentucky Rock Asphalt Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Pierce-Arrow Motor Car Co.

Automobiles.
Ford Motor Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Brick, Paving.
National Paving Brick Mfrs. Assn.

Bridges.
Luten, Daniel B.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping
Littleford Brothers.
Pawling & Harnischfeger

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Gun Work.
Indiana Gunite & Const. Co.

Cement Testing.
Chicago Paving Laboratory.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chemists, Engineering
Chicago Paving Laboratory.
Dow & Smith.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Clay Pipe, Vitrified.
Clay Products Assn.

Clay Products.
Clay Products Assn.

Concrete Bridges.
Luten, Daniel B.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Rosing, Inc., Astrid S.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, Burdick & Howson.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Druar & Milinowski.
Flood, Walter H., & Co.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Md., Baltimore—City plans to improve 11 sts. and aves.; including 3rd St., Evergreen, Haddon, Glenmore Aves. Edw. J. Hecker, City Surv., Howard W. Jackson, Mayor; Stewart Purcell, Chf. Engr.

Miss., Oxford—Lafayette County plans bldg. concrete Indian Trail Rd.—Memphis, Tenn., to Birmingham, Ala., thru north Miss. Est. cost $1,200,000; Lafayette Co. and Fed. Gov. each paying half.

Mo., Maryville—City plans to pave from 12 to 32 blocks. W. O. Garrett, Mayor; Merle Cooper, Clk.; E. T. Archer & Co., Engrs., 609 New England Bldg., Kansas City, Mo.

Mo., St. Louis—City will receive bids about March to rebuild and widen Olive St.—60 to 100 ft. below 12th Blvd. and Channing Ave. Est. cost $2,000,000. Maj. Clinton H. Fisk, Director of Sts. and Sewers.

Neb., Brainard—Ordinances proposed for Street Impvt. Dists. Nos. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12. Village Clerk Manley Falk.

Nev., Carson City—Plans being prepared on following: 7 mi. conc. and gravel Sparks-Hafed Rd., Washoe Co.; 16 mi. grading Hafed-Derby, Washoe Co.; 22 mi. grav. surf. Shoshone Point to E. Co. line, Fure'a Co.; 7 mi. grav. surf. Conners Pass to S. Co. line. White Pine Co.

Nevada—Fed. Aid. Proj.—Nevada Proj. No. 52, Clark Co., 16.02 miles approved. Est. cost $151,000.

N. D., Minnewaukan—State Hwy. Commn. has been requested to make surveys of York-Knox Rd.; also rd. 8 mi. west of here and 9 miles west of Ft. Totten, to connect with gravel hwy. so. of here; also asked for Fed. Aid for graveling main hwy. betw. Niles and Leeds and 7 miles west from Minnewaukan. G. A. Gilbertson, Benson Co. Aud.

N. D., Minot—H. C. Frahm, Directing Engr. of N. Dak. State Hwy. Comn., estimates about 100 miles new rd. work to be started in 1925 in 12 northwestern counties of Minot Div. of N. Dak. Comn.

N. D., Stanley—Plans being made for Fed. hwy. constr. for 1925, Mountrail Co. Includes exten. for hwy. no. of Stanley for about 15 miles; completion of 6 miles betw. Stanley and Van Hook; also contemplate 10-mile road proj. near Parshall and so. of Parshall, 7 miles toward Elbowoods. Frank J. Haines, Co. Aud.

Ore., Astoria—County budget calls for appropriation of $464,182.36 as completed by Budget Committee. Largest single item is $50,000 for extension of Nehalom Hwy. If this item is accepted in final levy, as it undoubtedly will be, the fund for work on this hwy. will be $118,000.

Ore., Marshfield—Cooss Co. has budgeted for impvt. of hwys. within its precincts in 1925, $148,000. This general road fund is in addition to special taxes voted by many of the road districts which amounts to many thousands more.

S. C., Newberry—City plans street paving. $150,000 bonds voted.

Tenn., Harriman—City plans street impvts. $95,000 bonds voted.

Tex., Austin—Travis County plans bitum. macadam surf. of State Hwy. 20; Austin-Houston Rd. extending 2 mi. thru Mano. Approx. cost $278,000. Mr. Leonard, Co. Engr.; Geo. S. Matthews, Co. Judge.

Tex., Boston—Bowie County will receive bids in January for 2 sections of roads: 10.71 miles 18-ft. conc. pavement and .93 mile 20-ft. conc. pavement on State Hwy. No. 5—Texarkana to west side of Precinct No. 1 line. Tst. cost $394,000. D. K. Caldwell, Co. Engr., Texarkana.

Tex., El Paso—El Paso Co. will receive bids in near future for 15.2 miles bitum. surf. on black base on State Hwy. No. 1—Ysleta to Fadens. Approx. cost $410,500. F. W. Wilson, Co. Engr.; E. B. McClintock, Co. Judge.

Tex., Houston—City plans to pave roadway down both sides of waterway; will vote in April on $150,000 bonds for each road; will vote, also, on bonds for paving and san. and storm sewers. O. F. Holcombe, Mayor.

Tex., Lubbock—City plans streets impvts. $125,000 bonds voted. E. R. Friend, Mayor.

Tex., Quanah—Hardeman County plans to pave Colorado-to-Gulf Hwy. thru County. Contemplates $600,000 bond issue.

Tex., San Antonio—City will pave and curb 19 blocks Westfall Ave. at cost $90,000. John W. Tobin, Mayor; I. Ewig, City Engr.

Va., Richmond—City plans to expend $775,000 for street improvements. R. Keith Compton, Director Pub. Wks.

Wis., Appleton—Contemplate paving about 5 miles in 1925. Bids on 3 types concrete. Probably brick pavement on Cherry and Leminwah Sts. E. L. Williams, City Clerk.

Wis., Columbus—Ready for bids in March, 1925, for about 23,169 lin. ft. curb and gutter, 3,000 c. y. excav. and 13,088 sq. yds. paving with asph. conc. or 1 course r. c. on several streets and avenues. W. F. Reichardt, Watertown; Wm. H. Pientzner, City Clerk.

Wis., Kenosha—Kenosha Co. Rd. voted $360,000 bonds for improvement of 14 miles of road with concrete during 1925. Roads to be improved are 9 miles on Silver Lake-Twin Lakes Rd. do. from Geneva rd. intersection; 2-mile extension of Somers Rd. and 3-mile exten. on Burlington Rd. John Herzog, Commr.

Wis., Madison—Columbia County Board, Portage, has appropriated $20,000 for tar surf. treatment of trunk hwys. Nos. 10, 29, 31 and 33. J. T. Henton, Commr., Chippewa Co. Rd. (Chippewa Falls), has approp. $225,000 for county and state aid road constr. in 1924. W. H. Taylor, Commr.; Brown County Bd., Green Bay voted to construct 2 miles on Hwy. 57 to S. county line; 2 miles on Trunk Hwy., 96 and 1¾ miles on Hwy., 16 in northwest section of county. G. J. Cormier, Commr. Grant Co. Bd., Lancaster, voted to surf. abt. 90 miles rd. with crushed stone and gravel during 1925, 1926 and 1927. Following rds. to be surfaced in 1925: Trunk Hwy. 35, Hackett to Bloomington, $8,000; T. H. Blatteville to Ellenboro, $15,000; T. Hwy. 11, Fennimore to Boscobel, $20,000; Co. Trunk G, Muscoda end, $10,000; Co. Trunk, O, Cassville end., $10,000; Co. Trunk E, Liberty sch. hse. to Stitzer, $6,192—total $69,192. Henry Mink, Commr.

Wis., Monroe—Green Co. Rd. appropriated $295,000 for constr. of roads with concrete and gravel during 1925. C. J. Smith, Commr.

Wis., Racine—Racine Co. Bd. voted $94,000 for constr. with concrete County Trunk East, west of Thompsonville, abt. 4 miles. W. A. Bechtold, Commr.

SEWERAGE AND SEWAGE TREATMENT

Ala., Fairfield—Dr. C. J. Donald, representing Fairfield Exchange Club, petitioned Board of Revenue for extension of san. sewer system to Rutledge Springs.

Ark., Fayetteville—City considering issuance of $100,000 bonds for sewers.

Cal., Blythe—Resolution of intention 81 adopted by City for sewage pumping station, consisting of reinf. concrete sump., two 4-in. elec. sewage pumps, switches, wiring, connections, etc.; 12-in., 10-in., 8-in., 6-in., vit. pipe sewers; latter to be constructed in Donlon St., Main and other sts. Marie Crenshaw, City Clerk.

Cal., Dos Palos—Cons. Engr. W. E. Bedesen, has completed plans for sewer system and treatment plant for Dos Palos San. Dist. involving treatment plant on Branch Canal No. 2 (Imhoff tank with sprinkling filter system to serve 1,000 pop.), construction of lat system and main outfall. Election soon to vote on bond issue for this wk.

Cal., El Segundo—R. T. Hutchins, City Engr., preparing plans for combined gravity and pumping san. sewerage sys., designed to serve present population of 3,000; also potention population of 15,000. Trunk lines are chief engineering feature of this system and will necessitate some deep cuts and tunnel work. Complete plans and est .of cost available at early date.

Cal., La Verne—Engineers Black & Veatch, 617 Ferguson Bldg., report that plans for sewer system here and joint outfall have been approved by State Board of Health. Lateral system will involve 8-in. and 10-in. pipe. Outfall will be 3 miles of 12-in. and 15-in. pipe. Est. cost $80,000. Bonds sold.

Cal., Los Angeles—Further plans for proposed

BUYERS' GUIDE

Deep Well Pumps.
Harris Air Pump Co.
Keystone Driller Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Dryers.
Cummer & Son, The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Machinery.
Westinghouse Electric & Mfg. Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Excavating Machinery.
Austin Machinery Corp.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co., Inc.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Gates, Sluice.
Coldwell-Wilcox Co.

Graders.
Austin-Western Road Machinery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gunite.
Indiana Gunite & Const. Co.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Mead-Morrison Mfg. Co.

Hot Mixers.
Austin Machinery Corp.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corp.
Koehring Co.
T. L. Smith Co.

Motor Fire Apparatus.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Duplex Truck Co.
Federal Motor Truck Co.
Ford Motor Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers, and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

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National Paving Brick Mfrs. Assn.

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Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
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Paving Plants (Asphalt).
Austin Machinery Corporation.
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Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

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W. W. Strickler & Bros.

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Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Metropolitan sewer system include Montebello, Rivera, Belvedere, City Terrace, Belvedere Gardens, Downey, Clearwater, Hynes and Bellflower, under Dist. No. 2. P. F. Cogswell, Supvr. Dist. 2. Total cost of Metropolitan system est. by Co. San. & Draining Engr. Albert K. Warren, at $14,000,000. Will care for needs of practically entire co. outside Los Angeles for 25 years. Discharge point selected at White's Point west of Pt. Firmin, San Pedro.

Cal., Porterville—Proceedings started for election to vote on bond issue for sewage disp. plant. Final plans of Currie Engrg. Co., Alhambra, show cost of $50,000 for the impvt. State Board of Hlth. has ordered work.

Ont., Maidstone—Maidstone Twp. plans to expend $100,000 for 7 or 8 miles tile drains. Engineer not selected.

Ill., O'Fallon—Sewer system at cost of $97,000 is to be installed here.

Ia., Cedar Rapids—Will bring plans up for action early in 1925 for storm sewers in Central Park. Will probably enlarge drain area and capacity of sewer, also will vote on $50,000 bond issue. L. J. Storey, City Clerk.

Ky., Somerset—$135,000 voted here for sewer and paving.

Md., Baltimore—Public Impvt. Commission voted to expend $63,000 for installation of san. sewers and storm water drains. Bernard L. Crozier, Hwys. Engr.

Minn., Rochester—Will take bids early in spring for sewage disposal plant. A. F. Wright, City Clerk; Chas. H. Armstrong, City Engr.; Frederic H. Bass, Cons. Engr., 515 Se. 6th St., Minneapolis., R. C. constr. Est. cost about $350,000.

Neb., Omaha—City plans to vote on $5,000,000 bond issue to rebuild sewer system. H. Beal, City Engr.; Jas. P. Hoctor, City Clerk. Prelim. plans being made for extending and enlarging brick or rein. conc. sewers in 6 blocks on Jones St. Est. cost $125,000. H. Beal, City Engr.

N. C., Cary—City will expend $30,000 for sewer system. Gilbert C. White, Engr., Five Points, Durham. E. C. Yates, Clerk.

Ore., Klamath Falls—Sewer constr. work, costing approx. $200,000, will be completed by City during 1925. Pipe lines will be more than 17 miles in length.

Pa., Newcastle—$300,000 bonds voted for sewage disposal plant on 38-acre site in Taylor Twp.

W. Va., Rivesville—City will construct sewer and water system. $500,000 available.

Tex., Crowell—City (J. E. Kimmer, Secy.) has prelim. surveys by F. E. Devling, Engr., 614 Bitting Bldg., Wichita, Kan., for sewerage system. Est. cost $50,000.

Tex., Livingston—City voted $40,000 bonds for san., sewers and disposal plant. W. D. Willis, Secy.

Tex., Lubbock—City voted $25,000 sewer bonds. F. R. Friend, Mayor.

Tex., San Angelo—City having prelim. survey made by Terrell Bartlott, Engrs., 612 Calcasieu Bldg., San Antonio, for sewerage system, including disposal plant and extension of mains, etc.

Va., Richmond—Finance Committee of City Council, recommended expenditure during 1925 of $450,000 for sewers; $1,300,000 for Shockoe Creek and $150,000 for gas works, etc.

WATER SUPPLY AND PURIFICATION

Cal., Los Angeles—Franchise granted by County to Chas. H. Quandt for water pipes (not exceeding 16-in. diam.) in certain streets near Medow Park Tr., Long Beach and Redondo Rd., as per Ord. 1180; granted to Morgan Water Plant for water pipes (not exceeding 8 diam.) in dist. bounded by Main, 104th Sts., Central Ave. on s. by P. E. Ry. and in portions of Central Ave., Hooper, So. Park, 94th and San Pedro Sts. Ord. 1178; granted to L. A. Gasoline Co., for natural gas, pipe line (not exceeding 12½-in. diam.) in dist. bounded by Beacon St., Walnut St., s. city limits of Torrence, Chestnut St., Narbonne Ave. and other thoroughfares, as per Ord. 1174; granted to Associated Oil Co. by County for oil pipe line (19-in. diam. and telephone line in Lincoln Ave. betw. Montebello and San Gabriel Blvd.; also in portions of San Gabriel Blvd., Durfee Ave. Workman Mill Rd. and other streets; to L. J. Seymour, by County for water pipe lines (8-in. or less), in Tracts Nos. 7888, 8222, 5498, 7782 and 7861. Maude B. Beatty, Clerk of Supvrs.

Cal., San Francisco—Mortimer Fleisacker, Pres. Great Western Power Co., has announced that plans are under way for a $2,000,000 dam and reservoir on the Feather river, providing storage for 1,300,000 acre-ft.

Cal., Santa Barbara—City Mgr. Nunn and Victor E. Trace of Water Dept. authorized by city to call for bids for material and equipt. for water impvts., totaling about $230,000. $1,000 (of this sum) will be expended on outlet reservoir No. 1; $10,000 on new services and meters; also large part of balance for water mains.

Cal., Whittier—City plans to purchase 2,000 ft. 4-in. Cl. C, also 1,000 ft. Cl. B 6-in. cast-iron pipe with fittings, gate valves, etc. P. Gilmore, City Clerk.

B. C., Nanaimo—City Council considering matter of expending approx. $150,000 on water works impvts. This would increase supply to 1,000,000 gals. per day. Plan involves laying approx. 29,000 ft. water main pipe and would ultimately form part of general impvt. scheme capable of delivering 2,000,000 gals.

Que., Quebec—City plans to construct new mains at cost of $700,000; also 20 m. g. steel reservoir in Battlefield Park, $100,000. W. D. Baillarge, Quebec, Engineer.

Fla., Bradentown—$330,000 bonds voted for water works; $200,000 for gas plant; $141,000 for san. sewers; $72,000 for storm sewers.

Fla., Deland—$130,000 water works bonds voted here.

Fla., St. Augustine—City votes Feb. 10th on $415,000 water works bonds.

Ill., Dixon—City Council awaiting plans and specfs. from officials of Dixon Water Co. for additional protection on North Side by constr. of emergency water main line. C. E. Miller, Commissioner, has explained to Council that this line can be rested on tops of piers of Galena Ave. bridge with valves at each end and in case of emergency calves can be opened, shutting off service in old pipe line on river bed.

Ia., Clarinda—City water plant inspected. Will probably install additional motor and pump. C. L. Lambert (Burns & McDonnell Engrg. Co.), Kansas City, Mo., Engineer. Henry Traxler, City Clk.

Md., Fredericktown—$112,000 water works bonds voted here.

Mass., Worcester—City and Metropolitan Dist. Comn., 1 Ashburton Pl., Boston, plan 3rd additional pumping unit, etc., at Wachusett Reservoir of Metropolitan water system to furnish water supply to depleted reservoirs. $50,000. J. R. Rablin, 1 Ashburton Pl., Boston, Engineer.

Mo., Kansas City—Plans being made, and bids will be received about March 15th, for steel pipe, lifting station, settling basin, purification and filtration plants; also 2 tunnels. Fuller & Maitland, Walsix Bldg., Engrs.

N. J., Perth Amboy—Board of Water Commrs. here recently passed resolution to provide for appropriation of $155,000 for constr. of mechanical filter plant for iron removal at City water works.

N. C., Cary—City will expend $50,000 for constr. of water works. Gilbert C. White, Engr., Five Points, Durham, N. C.

N. C., Goldsboro—$150,000 bonds authorized by City for water wks., sewers, cemetery, etc.

O., Alliance—City of Alliance has retained Cons. San. Engr. George B. Gascoigne of Cleveland, to supervise the enlarging and improving of the water works of City.

O., Cincinnati—At recent meeting of officials and residents of villages of No. Bend, Addyston and Cleves in Ohio, plans were formulated to extend water supply from Cincinnati to these points. D. W. Gwaltney, Mayor of Cleves; Wm. Gray, Mayor of Addyston; Clarence Hopping, Mayor, North Bend. Judge Stanley Struble selected and will supervise arrangements of extension of system.

BUYERS' GUIDE

Pumps.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

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Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
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Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
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Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
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Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

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Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.

Rock Asphalt.
Kentucky Rock Asphalt Co.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Scarifiers.
Austin-Western Road Machinery Co., The

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

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Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
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Truscon Steel Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Clay Products Assn.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Sewer Pipe Joint Compound.
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Dallmann Machine & Mfg. Co.
Good Roads Machinery Co., Inc.

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Austin-Western Road Machinery Co., The

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Keystone Driller Co.

Steel Joists, Studs and Sash.
Truscon Steel Co.

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Lighting.
Holophane Glass Co.
Westinghouse Electric & Mfg. Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch.
The Barrett Co.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

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Austin-Western Road Mach. Co.

Tractors.
Best Tractor Co., C. L.
Ford Motor Co.
Holt Mfg. Co., Inc.

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Warford Corp.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
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The Hug Co.

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Clay Products Assn.

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National Water Main Cleaning Co.
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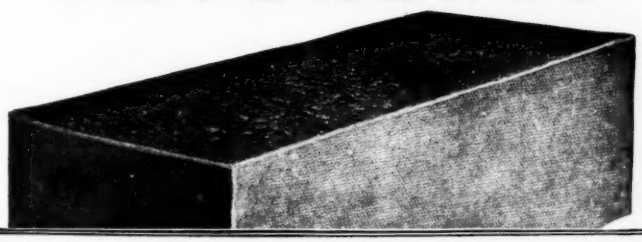

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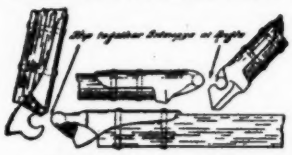

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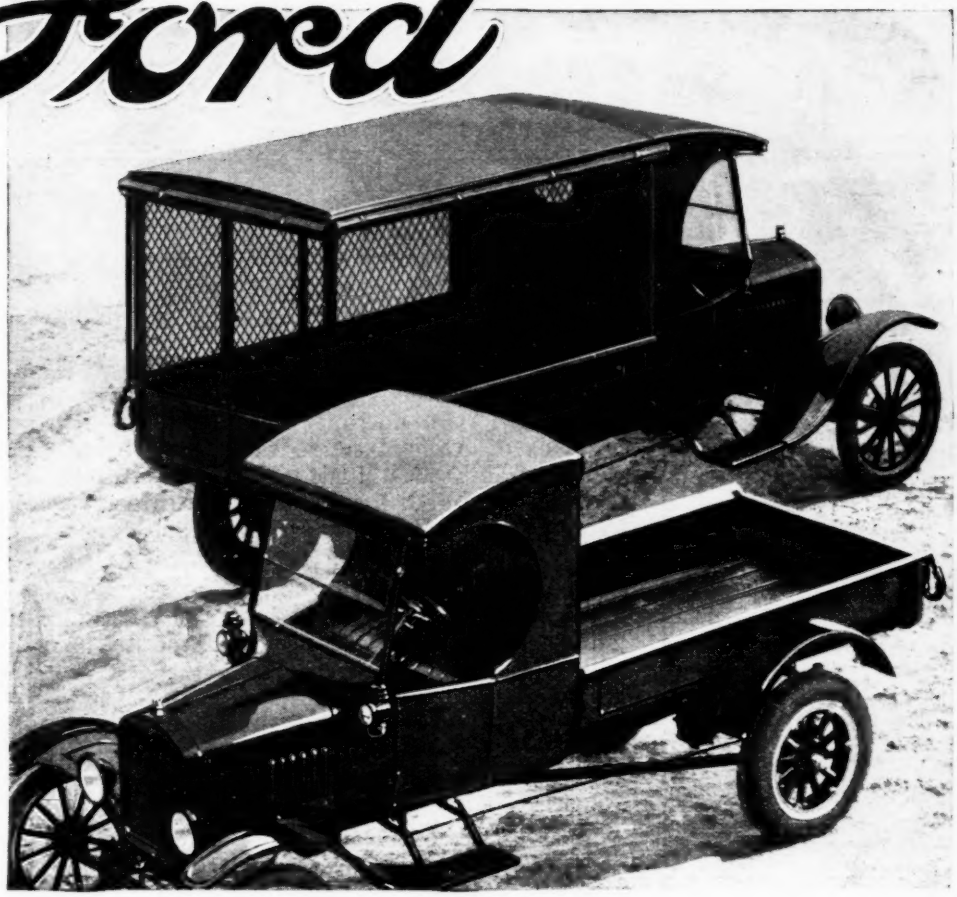

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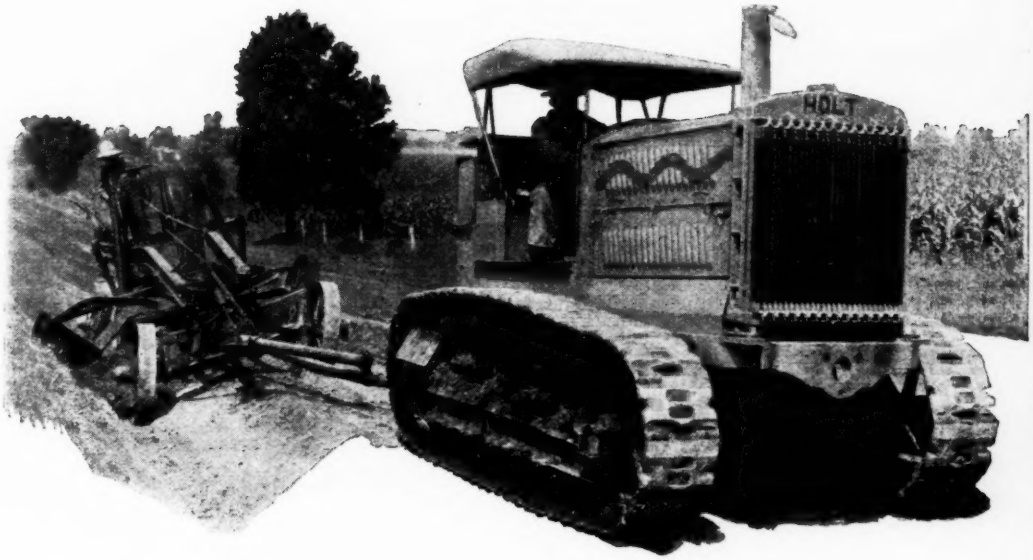

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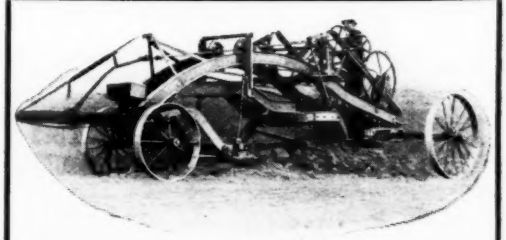

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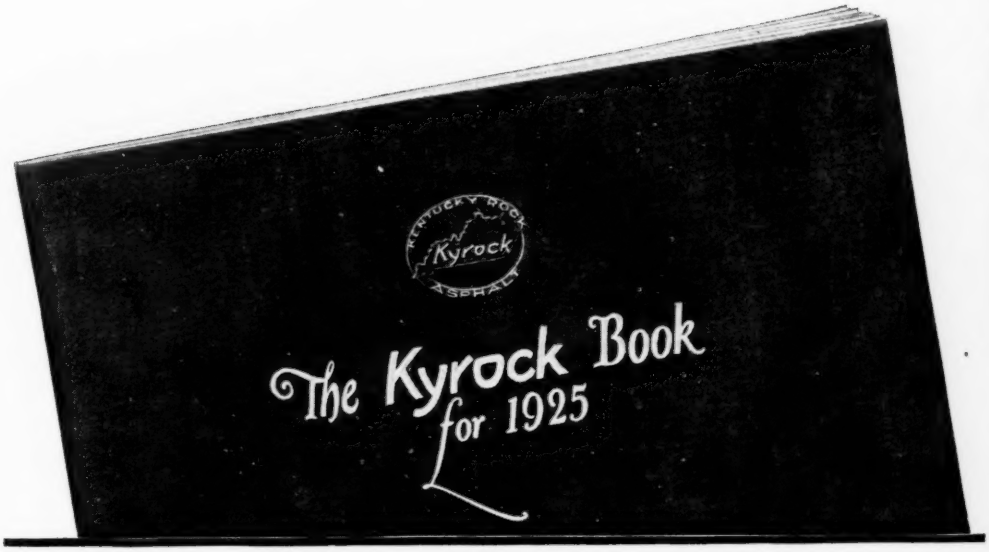

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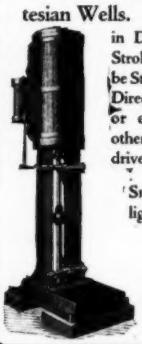

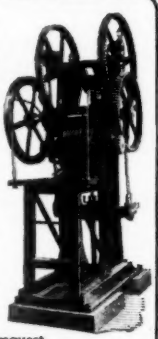

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EVOLUTION OF HIGHWAY CONSTRUCTION AND MAINTENANCE EQUIPMENT

By O. L. Kipp, Construction Engineer, Minnesota Highway Department, 1216 University Ave., St. Paul, Minn.

There has been a marked evolution during the past ten years in practically all types of highway construction and maintenance equipment. The scope of this evolution is so broad that it is not possible within the limits of the time assigned to do more than point out in a general way the trend of the developments which have taken place. This evolution has been due largely to three major factors.

(1) The greatly increased volume of funds which have been made available for highway construction and maintenance during this period.

(2) During this period there has been an increase in adaptation of gas engines and motor equipment to highway construction and maintenance work.

(3) This period has seen radical economic changes due to and following the war which have contributed in no small way to the development of highway construction and maintenance equipment.

It is timely therefore that we consider the changes in construction and maintenance equipment which have been developing during these past ten years.

1. Grading Equipment

Let us consider first the changes in grading equipment. Elevating graders which had been developed prior to this time largely in railroad work were transferred to the highway construction field without modification. The standard power layout consisted of 8 head of horses or mules in front, driven by one man, and 4 head driven by another man from the "push." In many cases 4 additional head with a driver on a two-wheeled cart were added in front and were commonly known as the gig team. Power was first substituted for stock by using round wheel gas or steam tractors adapted for farm work and for use with threshing rigs. These first efforts in the use of power were not very successful as too much time was lost in turning and the tractors were not adapted to use over rough ground, nor on soft and slippery soil. The "caterpillar" tractors first introduced about 10 years ago, overcame these objections largely, but they did not displace stock to any marked extent prior to 1918. Since that time, however, the substitution of "caterpillar" tractors for stock on elevating graders has been growing rapidly with increasing success and the tractor runner is rapidly taking the place of the push and gig team drivers and the "high-up" driver who from his high seat so dexterously managed his 8 head of stock.

There has been less progress, however, in displacing the use of stock on wagons. While there has been a large amount of experimental and pioneer work in the use of tractor drawn wagons, trailers and carts in conjunction with elevating graders, these have not displaced team drawn wagons as yet to any very marked extent. As each year brings an increasing number and variety of mechanical substitutes for team drawn wagons, it may be that the days of the old-time grading skinner are about numbered.

Power Shovels

The adaptation of power shovels to ordinary highway construction has been very rapid and successful. The early development of power shovels in railway construction, drainage, mining and industrial work did not produce a shovel entirely adapted to the average highway construction conditions. These conditions demanded greater mobility and greater flexibility. Greater mobility is being supplied by the rapid development and growing use of crawler or continuous tread traction, not only on light revolving type shovels but also on the heavy duty railway types. This type of traction enables the shovels to move over rough and soft ground under their own power without blocking or leveling and therefore with but little delay and expense.

While steam still maintains the leading position in shovel construction gasoline shovels are being developed rapidly, because of the advantage obtained by their use where coal costs are high or where feed water is difficult to obtain or when pipe lines are likely to freeze. Under such conditions the willingness of gasoline dealers to deliver gas to the shovel at tank wagon prices gives the gas shovel a material advantage.

A further development in the displacement of steam for shovel power was accomplished when a small type shovel was recently equipped with a mechanical injection oil engine of the Diesel type, for which substantial economies are claimed.

Hauling Equipment

The use of the power shovel on highway construction has been greatly increased also by the development of haul-

ing equipment suitable for use in conjunction with it. Formerly the horse drawn wagon or car and track with horse or steam dinkies were used for hauling the excavated material from the shovel. These are being displaced to an increasing degree by motor trucks and gasoline industrial locomotives. Motor trucks are especially useful where a considerable percentage of the material must be hauled 1,500 ft. or more and where hauling conditions will permit of their use. Where hauling conditions are not favorable to the use of trucks and the quantity of excavation per mile is sufficiently large, car and track can be used to advantage as on railroad work. If the haul is short or the output of the shovel is low, as in rock excavation, teams are still used to advantage as motive power on car and track work. With longer hauls and larger output the gas locomotive has taken the place of the steam dinky once so common on railroad work.

Pneumatic Equipment

In rock excavation on highway construction there has been a rapid and extensive development of portable air compressors and pneumatic drilling tools. Wherever rock excavation constitutes any considerable volume of the work hand drilling has given place to the pneumatic drill and portable compressor. This equipment has also displaced the use of steam with steam drills to a large extent in rock drilling on highway work. The tendency is toward greater mobility in the compressors and a wider range of sizes and greater individual air capacities.

Explosives

In connection with rock excavation a wider variety of explosives have been available as a result of the world war. However, the standard grades of dynamite and powder are still largely used. As a detonater the electric battery has been developed with a wide range of sizes adapted to use with the various sizes of drilling outfits. In addition to the electric battery the usefulness of Cordeau-Bickford as a detonater has been brought to the attention of grading contractors. Cordeau-Bickford is a detonating safety fuse consisting of a lead tube filled with tri-nitrotoluene. The advantage of Cordeau-Bickford is derived from three important qualities. First, there is absolutely no danger in its handling or storage. Second, its average rate of speed is 17,500 ft. per second, and the rate of propagation and effectiveness does not diminish. Third, it increases the efficiency of the explosive charge.

With all the developments in excavation methods and equipment it is worth noting that there are still conditions under which road grading can be performed most economically by station men and hand methods. This fact should not be entirely lost sight of by grading contractors in their enthusiasm for modern equipment and methods.

Blade Graders

With the development of tractors the blade grader has grown in size and usefulness. In side borrow work it has displaced to some extent the elevating grader and the fresno wheeler and slip grader. Many attachments have been added such as the back sloper and the scarifier which extend its range of service. The results obtained in finishing with a tractor and 12 ft. blade grader, makes this blade grader an almost indispensable part of a grading contractor's equipment, especially if the work is such that a "caterpillar" tractor can be used to advantage with other grading equipment on the job.

Fresnos, wheelers and slip graders still have a place in highway grading, although for the most part they are used as auxiliary equipment on large projects, or they are used alone on small jobs which would not warrant the use of larger equipment. Examination of the advertising sections of construction magazines shows an ambition on the part of manufacturers to motorize and enlarge the field of this type of equipment, but so far very little effect of such activity has been noticed around grading contractors' camps.

The growing tendency, which has already been noted, toward the inclusion of motor and tractor equipment in the highway grading contractor's layout, has resulted frequently in such contractors providing themselves with mobile camps having greater comfort, convenience and sanitation. Tents and tar paper shacks so largely used have given place in many cases to cook-houses, dining rooms and bunk houses mounted on trucks so that they can be moved as required by tractors or trucks ordinarily employed in the outfit. These buildings are well ventilated and screened for summer use and they can be easily heated when heat is required.

2. Gravel Surfacing Equipment

The past ten years have witnessed a very material change in the character and extent of gravel surface equipment. Prior to the last decade labor and teams could be obtained at such low rates that such mechanical equipment as was available could hardly compete with the more simple method of hand shoveling, hand screening and team hauling. The first departure from this method came with the introduction of tractors and trailer wagons. These were used to some extent in competition with teams until about 1918 when the growing efficiency and number of motor trucks gave this type of hauling equipment an increased advantage. With the close of the war the trucks released to the states as excess war material together with the increased output of truck manufacturers, made available such a large number of trucks that the prices bid for hauling by truck owners made them low bidders on practically all hauling work. Tractors and wagon trailers were unable to compete and the high cost of men and teams placed them at a disadvantage.

Motor Trucks

Within a period of a few years therefore, there has been an almost complete transition from team and tractor haul for gravel surfacing to truck haul. The trucks first used were largely 4 and 5 ton trucks on solid rubber tires. These were generally overloaded from 50 to 100 per cent and consequently the hauling contractors suffered much loss and delay on account of the undeveloped country roads being unable to carry the loads.

The results were not entirely satisfactory to the municipalities as such heavy hauling damaged the subgrade of the road being gravelled as well as the side roads over which it was necessary to haul. The advent of smaller pneumatic tired trucks was therefore welcomed and the results obtained have enabled this type of truck to occupy almost exclusively the rural hauling field where pavements or frozen grades are not available.

Gravel Loading Equipment

The development of hauling equipment from the team and wagon haul to the truck haul has been a large factor in the evolution of gravel loading equipment. Another factor has been the increased cost of labor, while a third factor is found in the growing demand on the part of the highway departments for a uniformly graded material passing a ¾ to 1 in. screen. Where the gravel deposits contain 10 per cent or more of oversized material, there is a growing demand that this oversized material shall be crushed and mixed with the gravel. On the other hand where the deposits contain an excess of fine sand a sufficient amount of material passing an ⅛ in. screen must be removed to bring the amount passing ¼ in. screen above 25 per cent.

The evolution of gravel loading equipment has therefore been governed first by economy of loading trucks from local pits of varying size and under varying conditions, and second by the necessity of producing a uniformly graded material. The wide variety of gravel deposits encountered has led to almost as wide a variety of equipment being used. In some sections the natural grading of the material so nearly conforms to requirements that the small amount of oversize can be satisfactorily removed by dropping the material through a "grizzly." Under such circumstances power shovels, cranes and elevating loaders have been used with an "A" frame, or other type of "grizzly" without a storage bin. Belt or bucket conveyors loaded by teams through a trap are also frequently used in conjunction with a suitable screen and a small storage bin. In general storage bins where used are becoming smaller and more portable and greater reliance is placed on the efficiency of the loading equipment in reducing loading delays to a minimum.

Where gravel deposits contain a considerable amount of oversize, a more efficient screening arrangement is necessary and the material is generally elevated by belt conveyors, drag lines or other means of shaker or rotary screens mounted on portable bins. Where a larger amount of oversize exists in the deposit, the State Departments generally require that the oversize material be crushed and mixed with the gravel. Many combinations and arrangements of conveying equipment, screens and crushers have been devised by individual contractors. Perhaps the most complete machine for this purpose on the market is that manufactured by a Minneapolis concern. This machine is comprised of a drag line for digging material from the pit and conveying it to a belt conveyor which in turn carries it to the screens. The oversize from the screens is carried to the crusher from which the material is again carried to the screen. The material passing the screen is carried to a small bin of but a few

yards capacity designed to hold the output of the plant during the interval ordinarily occuring between trucks. From this storage bin the material is carried to the truck by a large capacity belt conveyor which will load a truck in a few minutes. Power is furnished by gasoline engine and the whole outfit is mounted on wheels so that it can be readily drawn by a truck or tractor.

Spreading and Compacting Gravel

The evolution which is taking place in the spreading and compacting of the gravel surface is, as much a matter of method as of equipment. Ten to 15 years ago there were 2 types of gravel surface construction. One followed in a general way a water bound macadam specification. The other was employed largely on township work and consisted merely of dumping a row of pit run gravel along the side of the road and leaving it thus with little if any effort toward securing a uniform surface.

Our present method of spreading and compacting requires less equipment than the macadam method. The first requirement now is a smooth compacted subgrade with little if any crown. This is most successfully obtained ordinarily by maintenance with heavy equipment such as a tractor and 12 ft. blade or large planer. The uniformly graded gravel is dumped from the trucks upon this subgrade as evenly as possible. It is then spread with a blade grader and all but approximately an inch of the material is shoved into windrows along each edge of the subgrade. On the 30 ft. subgrade ample width is available between the windrows for traffic. The thin layer of gravel in the center of the road is maintained by the maintenance patrolman with his regular maintenance equipment. The traffic is depended upon to compact this thin layer and as fast as this result is obtained additional material is brought from the shoulder windrows until all the material has been compacted. Where there is any tendency to develop waves or any other irregularities in the surface a tractor and heavy blade with scarifier attachment, if necessary, is used to correct the defects.

3. Paving Equipment

Prior to the past decade paving equipment has been developed largely to meet city paving conditions and the current practice in connection with such work. With the extensive rural paving programs which have been developed largely within the past decade there has come a comprehensive development in paving equipment which has affected practically every operation in pavement construction from the preparation of the subgrade to the curing of the pavement.

Fine Grading

Fine grading of the subgrade was once largely a matter of men with picks and shovels. Now this hand work is supplemented by small tractors with scarifiers and blade or by a subgrading machine riding on the forms and cutting exactly to the desired crown. The soil conditions encountered govern largely the method and equpiment best suited to this work, but the man with pick and shovel is no longer left to worry the job out unaided. Accuracy in the finish of the subgrade is insured by checking with a template of the specified section supported at its ends by the forms.

Forms

The side forms are now required to furnish not only more accurate alignment and grade to the finished pavement, but they are also called upon to guide the subgrader and to withstand the weight and movement of a finishing machine. These added requirements have resulted in the development of more rigid and adequately supported forms. Recent changes in pavement slab design have also added to this rigidity by placing the thickest part of the pavement slab at the outside edge instead of the center, thereby increasing the height of the form from 6 or 7 ins. to 8 or 9 ins.

While the operation of form setting is still largely hand work a machine known as a form grader has recently been developed for grading according to the depth required for the form.

Proportioning Aggregate

Perhaps the most far-reaching development has come in the method of handling and proportioning the fine and coarse aggregate. It is not many years since common practice allowed these materials to be dumped on the subgrade from carts, wagons or trucks with more or less mixing of subgrade with the aggregate, and more or less intermingling of the fine and coarse aggregate. With these materials dumped on the subgrade the time honored method was to shovel from the subgrade into wheelbarrows and wheel the material to the mixer skip, depending on the laborers to load the wheelbarrows uniformly to the proper amount, and to get

the correct number of wheelbarrow loads of each material in the batch.

With the increased cost of labor during the war there was introduced a belt conveyor with measuring boxes to eliminate the wheelbarrows. In some cases also a loader of the Barber Greene type was introduced to pick up the coarse aggregate and reduce the number of shovelers required. Development along this line came to an end as the engineers in charge felt the need of methods more certain to insure in the concrete, clean aggregate, more accurately proportioned, and specifications were drawn to prohibit placing concrete materials on the subgrade. With this change in specifications began the development of proportioning plants. Until the last few years the equipment for measuring fine and coarse aggregate have been largely devised by the contractor, his superintendent, mechanic or carpenter. More recently the manufacturers have developed and placed on the market measuring devices which have tended to standardize methods of measuring by volume. Hardly has this advance in accuracy been made before it has dawned on engineers that sand is subject to a wide variation in volume according to its moisture content and according to the conditions under which it is placed in the measuring box. This realization has lead to provisions for adjustment in the capacity of the sand measuring box to compensate for the swelling of the sand due to its moisture content. As a further step towards accuracy in proportioning concrete paving materials at least one state highway department has abandoned volume measurement of such aggregate and has adopted a method of proportioning by weight.

Central Mixing Plant

With the elimination of material from the subgrade and the development of proportioning plants, considerable development has resulted in concrete paving mixers. The use of a central mixing plant instead of a so-called paving mixer on the subgrade has consisted merely in designing a proportioning plant to discharge directly into an ordinary building mixer, which has been mounted sufficiently high so that it can be discharged into the hauling trucks. It does not appear that any definite type of central mixing plant layout has been developed, as nearly every contractor using this method has designed his layout according to his own ingenuity and the conditions surrounding his set-up.

The use of the central mixing plant was made practical by the evolution which has taken place with regard to concrete consistency and the discovery that concrete of the desired consistency could be hauled almost any required distance without separation of its aggregates, or any injurious effects to the concrete.

Paving Mixers

In paving mixers there has been a very marked evolution. First, greater portability has been secured by substituting continuous traction for the old type of wheel traction. Second, suitable gas engines have been developed to such efficiency that they are practically as reliable as steam power for mixers. Third, power hoists have been developed for transferring batch boxes from industrial cars and dumping them into the skip or directly into the mixer. Fourth, timing devices have been developed automatically to regulate the length of time the batch remains in the mixing drum. Fifth, means have been provided for more accurately gaging the amount of water added to each batch.

In the matter of transporting materials to the paving mixer there have been two general methods in use, namely, industrial haul over portable tracks and hauling over the subgrade with wagons or motor trucks.

Industrial Railway Hauling

The industrial haul method used by Wayne Co., Michigan, early in the paving program, remains practically unchanged as to method. The principal changes in this connection consist in the number of industrial locomotives available and their mechanical improvement. As compared with industrial haul there has been a greater change in the methods of hauling over the subgrade. Teams gave way to motor trucks and these have changed largely from heavy trucks on solid tires to lighter trucks on pneumatic tires. Various types of dump bodies have been developed but no particular type predominates.

Truck Hauling

With the use of trucks, turn-tables for turning trucks on the subgrade, have been developed and at least one truck is on the market which has the same gear ratio both forward and backward and which can be driven backward as well as forward, thus eliminating the necessity of turning the truck on the

subgrade.

Where the subgrade is soft a large portion of the objection to truck haul has been removed on many contracts by providing plank runways for the last 50 to 100 ft. adjacent to the mixer. The use of these runways insures a satisfactory subgrade. This projection for the subgrade is especially necessary where truck haul is used with a central mixing plant.

Finishing Machines

The development of finishing machines and equipment has made it possible to finish concrete with a stiffer consistency, which results in securing a greater strength of concrete from the materials used. In general the finishing machines used have been of two types. One method, termed the vibrolithic method, requires a hand strike off of the concrete after which a tamping or vibrating action is secured by the vibration of an off center motorcycle engine resting on a wooden mat about 2 ft. wide by 8 ft. in length. Following the tamping by this method the finishing is completed by belting in the usual manner.

The more usual method of machine finishing is with the type similar to the Lakewood machine which is perhaps most commonly known. This machine consists of a strikeoff template followed by a tamping bar and a mechanically operated belt.

Securing Smooth Surface

In order to be certain of securing a satisfactory riding surface the pavement must be tested for uniformity of surface with a straight edge not less than 10 ft. in length. Ridges and depressions discovered by this means must be worked out and the whole surface given a final belting before the initial set of concrete takes place. A large proportion of the surface irregularities ordinarily left by a finishing machine can be removed by pulling a wooden float 10 to 12 ft. in length transversely back and forth across the pavement. This float ordinarily shaves off the ridges and fills the hollows, thus practically eliminating the hand work which might otherwise be necessary to produce a satisfactory surface. A further advantage is gained in the use of this float due to the fact that surplus water, if any, can be removed over the side forms by its operation.

Hand Finishing

Hand finishing is still used on many contracts almost entirely, while it is used to some extent on every contract where there are sections of irregular width. The most common development of hand finishing methods requires first that the concrete be struck off and tamped by a strike-off template, second, that the surface be rolled with a Macon roller or floated with a transverse float, and third that the finishing be completed by a final belting just before the initial set.

Pavement Curing With Calcium Chloride

There has recently been developed a new method of pavement curing with calcium chloride. This method eliminates the necessity of pumping water for curing and maintaining a pipe line back of the mixer. Where the central mixing method has been used in conjunction with calcium chloride curing, it has been found possible to eliminate the pipe line and pump entirely.

Bridge Construction Equipment

There is probably no phase of highway construction in which there has been more marked progress during the past decade than in the construction of highway bridges and structures generally. The equipment ordinarily used in the construction of bridges consists of concrete mixer and handling equipment, appliances for use in the handling and driving of piling, air compressors and riveting machinery and other means of handling excessive amounts of water. In addition to this there is special equipment used for excavation.

Ten years ago the use of concrete mixer on a rural highway bridge job was the exception rather than the rule. Today our specifications, in common with most of the other states, specify that a batch mixer must be used and that this mixer must have a minimum capacity of batch which will use not less than 1 sack of cement. Any graduation in size should be by sacks and not by fractional parts. The average successful contractor today employs not only a batch mixer but also a loading skip and other appliances for handling concrete materials and concrete both before and after the mix.

A few years ago, the majority of bridges were pin connected and in cases where riveted spans were used, it was almost universal practice to use bolts in making field connections. Today all

connections carrying stress must be riveted and we find the successful contractor employing air compressors and pneumatic riveting machinery.

Pile Driving

A few years ago the use of piling under bridge foundations was the exception rather than the rule in the case of smaller spans. If piling were required, they were usually driven by means of a small hammer and the power used in raising this hammer was in almost every case a team of horses. This was a slow process, which accompanied by the light weight of the hammer, made it very difficult to secure proper penetration and bearing for the piling. We now specify minimum weight of hammer 1600 lbs. and in case the driving is unusually difficult occasionally advise the contractor to procure even greater weight than this. In practically every case, when using hammers of this or greater weight, it is necessary to secure some form of power driven hoist for use in raising the hammer.

It was formerly the custom not to carry the foundations of a bridge to any great depth below the low water elevation. This eliminated the necessity of any large amount of pumping during excavation or pouring of the concrete for the footings. Engineers of today are not satisfied with stopping the bottom of the footing at water level, but in many cases require considerable depth of excavation, in order to secure adequate bearing to prevent scouring during flood season.

In addition it was formerly almost universal practice to place concrete under water. The changes in the methods of handling work have necessitated the use of much more pumping equipment on the part of the contractor. Centrifugal pumps and pulsometers are largely employed for this class of work.

Excavating

Excavation for bridge piers and abutments was formerly accomplished almost entirely by hand. This method at the time when labor prices were low and the excavation was not deep or troubled by an excessive amount of water worked out in a reasonably satisfactory manner. Today with high labor prices and greater depths of excavation below the water, other means must be employed. We find therefore that clam shell and orange peel buckets are often operated successfully inside of cofferdams, and even where the excavation must be by hand we find a bucket used for hoisting the earth to the waste bank.

Maintenance Equipment

The increased travel on the public highways following the wide-spread use of the motor vehicle, together with the adoption of federal aid laws requiring the maintenance of the Federal Aid System have resulted in the development by all of the states of definite though varied systems of road maintenance. As a result of this development the past 10 years have witnessed a very marked development in equipment adapted to highway maintenance. As a large percentage of the mileage has not yet been paved the work of surface maintenance has been chiefly concerned with earth and gravel surfaced roads.

Prior to 1914 such maintenance equipment as has been developed consisted chiefly of wood or steel counterparts of the original split log drag. Slight modifications had been made to provide for the tilting of the blades of these drags and some development was being made toward the adapting of such drags to tractor equipment. In addition to the drags light horse-drawn blade machines were used, but these were designed mainly for 4 or more horses and the present development in the lighter patrol type of blade graders had hardly yet started.

With the development of definite maintenance systems during the past decade we have witnessed to a general extent the passing of the old log drags and even the heavier steel drags have been supported largely by other equipment especially on gravel road maintenance. It is still conceded that the road drag can be used to good advantage on dirt roads if used at the proper time and under favorable conditions, but its use on gravelled roads has been quite generally discouraged.

Patrol Graders

The development of the maintenance on a continuous or full time basis has given rise to the team patrol organizations. The need for patrol graders resulted in a very considerable volume of business in this particular line of equipment. The early patrol graders were light machines weighing from 700 to 850 lbs. but these were found to be less satisfactory than the heavy patrol graders weighing from 1,100 to 1,300 lbs. The strengthening of the machine and its increase in weight has been accompanied by the use of longer mold boards and

cutting edges. This is especially true on gravelled road maintenance where the team patrol grader is now generally designed for use of an 8 ft. blade instead of the earlier 6 or 6½ ft. lengths. These graders have been strengthened also especially as to the wheels and boxings and other parts subject to wear, as the continuous use of patrolmen on gravel road maintenance showed a need for strength which had not been made apparent by the previous occasional use of these graders before continuous maintenance was initiated. Blade grader machines have also been developed to adapt them as maintenance equipment in conjunction with motor trucks and tractors. These larger graders are ordinarily equipped with 10 ft. blades and are mounted on roller bearing wheels with rubber tires.

Road Planers

In contrast to the gradual discard of the road drag there has occurred a development of the road planer designed primarily to overcome objections made to the use of the drag. Such planers usually consist of an arrangement of transverse multiple blades designed to shave off the high spots and fill the low places in the road surface. These planers have been developed to fit various types of hauling equipment. The team drawn size are made in 10 to 12 ft. lengths, while planers 16 or 18 ft. long are designed for use in conjunction with trucks, and the 20 to 24 ft. lengths are designed for use with tractors. Recent developments in the design of the planer include provisions for the changeability of cutting edge, adjustment of hitch arrangements to permit turning in the minimum possible space, and devices for raising the heavy planers to permit their being moved over railroad crossings or similar obstructions, or being transported considerable distances where necessary.

Tractors

The early use of power for hauling maintenance equipment consisted merely in transferring farm and steam tractors from the work for which they were designed to the maintenance work. No material progress war made in the use of power equipment for maintenance until the last few years when there began a very rapid development in the use of small tractors. On account of the low cost of operation of these tractors and the increased coast in team operation, the team patrolman is rapidly being supplanted so far as surface maintenance blading is concerned by the small tractor. Larger tractors, particularly of the "caterpillar" type, are now being used also to a large extent on heavy maintenance work such as reshaping of the shoulders and ditches, and scarifying and reshaping of the road surface.

In connection with the development of the small tractor there has been a corresponding development of the blade grader or modifications of the blade grader to permit the tractor to become an integral part of the blading machine. Such tractor installations usually involve steering control extensions to permit the operator to observe the working of the machine and its accomplishment from the rear. Many of these combinations involve also a double or triple set of blades instead of the single blade ordinarily used for grading work. Many of these machines also have made provisions for scarifying equipment and their increased weight and length of wheel base have contributed materially to the effectiveness of this machine as compared with a team drawn blade. Rubber tires are being used also on many of these motor patrol machines and this equipment is especially desirable where the machines are used largely on gravel road maintenance.

Use of Trucks as Power Plants

The use of trucks as power equipment in connection with maintenance operations has been largely without any modifications of the truck. In such cases the trucks are generally used only periodically for dragging operations while they are used mainly in the intervals between dragging for hauling surfacing material and other miscellaneous hauling work. The general tendency is toward the use of 2 or 3 ton trucks equipped with pneumatic tires on this class of work. Certain localities have made a special use of the truck in connection with road surface maintenance by equipping the trucks with a suspended spring blade attachment placed between the front and rear wheels, but the towing of heavy maintenance equipment is a more common practice.

Where the application of additional surfacing material is necessary the trucks have almost entirely superseded horse drawn equipment for hauling of such material. The operation of these fleets is practically identical with the

method already described under gravel surfacing except that the fleets are generally smaller and the loading equipment used in connection with them is smaller and more portable. Small drag lines and clam shells mounted on motor trucks have found a very extended use for maintenance purposes in connection with resurfacing operations.

The use of road oils on an extensive scale have developed more adequate storage facilities to insure a continuous supply of oil which is not obtainable directly from tank car shipments. Such installations call for proper pump and heating provisions as well as suitable tank capacities to fit the scope of the work. Oil heaters and distributors have been developed in connection with motor equipment and these have been improved to increase their efficiency in the heating and application of the heaviest oil as well as the lighter grades of bituminous materials.

During the past few years the use of calcium chloride in maintenance has developed to considerable proportions. This has led to the quite general use of the ordinary lime sower or similar spreading device attached to a motor truck. For extended use in this connection it has seemed desirable to strengthen the commercial lime sower especially as to running gear and also so as to increase its capacity with extension boards to provide a larger hopper.

Pavement maintenance on a larger scale required by the increasing mileage of pavements, has given rise to the development of equipment suited to the filling of cracks and joints as well as repairing or replacing of isolated slab sections. Crack filling work requires the use of brooms, hooks and other cleaning devices as well as adequate pouring pots and portable bituminous heaters.

Where considerable amount of slab repair work involving the breaking up of portions of the existing pavement is necessary, extended use has been made of paving breakers operated by compressed air from portable compressors mounted on trucks or trailers.

Traffic Line Painting

In order to increase the safety with the increasing traffic the practice of painting a line 4 to 6 ins. in width down the center of the pavement has become almost universal. For this purpose equipment has been designed for attaching to light trucks, which consists primarily of a marking wheel, guide and frame and hose connections for the flow and control of paint. The paint is carried in the truck body and flows by gravity to a nozzle above the marking wheel which transfers it to the pavement. When the edge of the pavement is clear so as to permit its use as a guide for the center line marking, considerable mileage can be obtained. Often as much as 20 miles have been painted by 1 outfit in a day and under such conditions the resulting cost per mile is very low.

Where but short stretches of road are to be marked, machines operated by one man have been devised. These machines use an air compressor mounted on a frame equipped with roller bearings, rubber tired wheels and a spray brush, the outfit as a whole being readily portable.

Snow Removal Equipment

Ten years ago there was practically no effort made toward snow removal or control on the rural highways. Such efforts along this line as were made by city forces depended entirely upon hand shoveling into team drawn wagons, except for such assistance as was rendered by plows attached to surface street car equipment.

The wide range of equipment now on the market for snow removal has therefore all been developed within the past decade. The problem of snow removal from rural highways corresponds to a large extent to the problem encountered by the railways in keeping their lines free from snow. However, the power equipment available for the railroads has not been available on rural highways and therefore it has been necessary to develop snow removal equipment suited to highway power equipment. Early efforts in snow removal involved the use of hand shoveling in the case of heavy drifts and the use of horse drawn blades where snow was not too deep to permit of such equipment being used. The development of "caterpillar" tractors has made available larger power units. In connection with power equipment, 3 types of plows have been developed, namely, blade plows, "V" plows and rotary plows. Various types of blade plows differ in detail particularly as to length, height and shape of mold board, but practically all have adjustments to permit changes in the cutting angle and elevation of the blade and usually safety

devices have been provided to prevent damage by obstructions which might be encountered. These plows can be attached to trucks as well as tractors and they can be operated very successfully where snow conditions are not too severe.

"V" shaped plows vary as to length and height of plow wings and a number of plows of this type have been designed to handle extreme snow fall and drift conditions. In many cases 4 wheel drive trucks hitched in tandem are operated in connection with this type of plow at a speed of 20 to 25 miles an hour, and the results obtained compare favorably with similar railway plows. Flaring wings capable of various adjustments as to width and height are also being used in connection with these plows to prevent the formation of side ridges. This feature of snow plow design is still deserving of considerable attention in the design of snow removal equipment.

Considerable experimental work has been under way during the past few years in the design of rotary plows suitable for use in connection with "caterpillar" tractors and many of these machines are now on the market. The most effective rotary plows include separate power equipment for the operation of the blades. The success which has already been obtained with this type of equipment justifies the belief that it will have a wide field of usefulness with the growing demand of the public for snow removal on the main trunk highways. Tractors and trucks adapted for snow removal work are being equipped with weather-proof cabs for the operators, and electric lighting systems to permit the snow plow equipment being operated continuously night and day, when necessary, in order to keep the road open.

More and more in connection with the problem of snow removal steps are being taken in the matter of snow drift prevention. As a result the last few years have witnessed the erection of a considerable mileage of snow fence. Owing to the need of setting such fences at some distance from the road proper, the item of portability has been properly considered and as a result the so-called railway type of snow fence is being rapidly superseded by picket fencing, consisting of wooden slabs about ½x1½ in. spaced 2 ins. apart and interwoven securely with a series of double strand wire. Erection is made on wooden or steel posts driven at intervals of about 10 ft. The use of such a fence on carefully selected locations greatly facilitates the work of keeping the roads open continuously and reduces the cost of snow removal.

Miscellaneous Equipment

The adaptation of small tractors to maintenance purposes has led to the production of mowing machines which can readily be attached to small tractors. Practically all such power mowers are designed with safety devices to prevent damage to the cutter bar as well as the tractor itself.

The development of pneumatic paint spray machines has led to their use in the maintenance of steel bridges instead of the hand method of painting structures Such machines are also quite frequently equipped with revolving wire brushes for cleaning the steel before the paint is applied. In addition to the economy in this new method there is a decided advantage in the spray method of applying paint over hand brushing as corners and surfaces inaccessible to hand brushing can easily be covered.

In conclusion, it will be seen from the foregoing that highway construction and maintenance is using to a constantly increasing degree motor traction and power equipment. This is an epoch of manufactured power and the use of such power is being adapted in an increasing way to construction and maintenance work. As a transformer of energy into useful work man is about the least economic machine in the world, says Richard T. Dana in his handbook of Construction Equipment. Working at top speed he can average in a working day not more than 1-18 of one mechanical horse power. It is therefore economical to reduce the accomplishment of human energy to the absolute minimum consistent with due coördination on the work. This means the substitution of equipment in place of human labor wherever it is possible to do so. Moreover horse power developed mechanically is very much cheaper than a horse power derived from teams guided by drivers. Thereore, wherever the same work can be done by machines that would otherwise be performed by horses, the former is economically preferable. These principles account for the substitution of power equipment for hand and team work which has already been accomplished as has been outlined and point to a still greater development along these lines in the future.

The foregoing paper by Mr. Kipp was presented at the 1925 meeting of the American Road Builders' Association.

DUTIES OF FIELD ENGINEERS ON HIGHWAY CONSTRUCTION

By B. H. Piepmeier, Chief Engineer, Missouri State Highway Commission, Jefferson City, Mo.

[Editor's Note: The following is the text of the Short Course Discussion for all employes of the Missouri State Highway Department of Construction, dated Feb. 6, 1925.]

Upon the field man rests the burden and responsibility of seeing that all road and bridge work is executed in accordance with the plans and specifications. A uniform quality of output must ever be the goal of effective supervision. It is, therefore, necessary that general policies and standard requirements of the Department be prescribed for the guidance of all field men, to insure uniform practice.

General Supervision

General supervision is carried on by field inspections made by the Engineer of Construction, aided by general inspectors from the central office at Jefferson City. During these general inspections, work is gone over in detail with the resident engineer and criticism and suggestions are made. Conferences are held with the contractor regarding progress. Where wrong practices are found, such suggestions and orders as seem pertinent for correcting the defect, are made to the engineer and the contractor. The general inspectors submit a written report to the division engineer and forward a copy to the Engineer of Construction.

Detailed Supervision by Field Men

The detailed responsibility of seeing that the work is done according to plans and specifications, that it conforms to the specified requirements for quality and quantities rests upon the project engineer. The faithfulness with which the project engineer carries on his supervision determines to a large degree the quality of the contractor's performance. Both contractor and engineer should have at the outset a complete understanding of the plans and requirements of the specifications, to avoid trouble and future misunderstandings.

Project engineers will usually be assigned to projects at least two weeks in advance of construction operations. Project engineers should and are required to locate their headquarters as near the work as is possible. They should familiarize themselves with the particular project and the work contemplated and then take up with the division construction engineer the matter of proper organization for the needed supervision. The necessary assistants, inspectors and rodmen will be assigned as needed. Transportation needed for the satisfactory prosecution of the work will be furnished, but will be as limited as possible. The use of privately owned cars on the basis of 7 to 8 cts. per mile, will be allowed only upon approval of the Superintendent of Equipment, when recommended by the Engineer of Construction.

Project engineers should "size up" with plans in hand and noting in detail their work by going over the ground all conditions. All drainage structures should be checked for size and length, and prospective borrow pits should be examined to see that they are ample and that sufficient right-of-way has been secured. In general, project engineers should ascertain that the plans are right before construction work begins. Orders for the removal of any poles or structures that will interefere with grading operations should be issued promptly, so that no delays will be incurred. As soon as project engineers establish their headquarters, they should notify in writing their division engineer of their postoffice, telephone and telegraph address. A copy of this letter should be sent to the Construction Bureau at Jefferson City. Project engineers are expected to be on the job at all times while construction work is in progress, and to supervise all operations regardless of the time it takes or the hour in which it is done. If, in an emergency, it is necessary for project engineers to leave their work, they should get permission and relief from their division engineer.

Project engineers are directly responsible to the division engineer for all men under them and for all state equipment assigned to their project. All correspondence relating to the work, equipment or supplies, should be directed to the division engineer.

Setting Stakes

The project engineer should reach his work in time to check the plans and be sure that they are correct before the

contractor commences work. Stakes will be furnished by the contractors on all work let after December, 1924. These stakes ordinarily should be set in accordance with the contractor's wishes, as far as plans permit. Ordinarily, in running the centerline, a stake should be set opposite each station (100 ft. intervals) on each right-of-way line to avoid its being disturbed during grading operations. Extreme care should be used in setting and marking these stakes, because they will be used to check slope and finishing stakes that will have to be set later. On curves stakes should be set at intervals of 25 to 50 ft., depending upon the curvature. Generally, unless otherwise requested, the grade marked on a stake should be the finished prifile grade. This marking should not show any allowance for earth shrinkage, which varies from 10 to 20 per cent, nor for any rock swell, which varies from zero to 33 per cent.

Slope stakes should be set at the top of all cuts and at the top of all fill slopes over 2 ft. in height. The location of these stakes must be determined by computations based upon standard slopes and upon instrument readings at points where the stake is to be set. The depth of cut or fill is to be marked to the nearest tenth of a foot with reference to the finished profile grade, shrinkage being disregarded.

All curves must be so staked and marked that proper superelevation will be secured. The amount of superelevation required will be shown on the plans or covered by instructions issued to project engineers.

On earth and gravel roads, finishing stakes and form stakes will ordinarily be set at intervals of 50 to 100 ft. on tangents and 25 ft. on horizontal and vertical curves. They must be set true to grade and alignment. All structures must be carefully staked and tacked for center lines, wing lines, and dimension lines.

Keeping Records

Project engineers are required to keep a diary in a regular note book, recording in detail all happenings of each day, so that such information will be available in settling questions of liquidation damages and any other disputed points that may arise in the course of the work.

The progress record will indicate the ability of a contractor to complete his work on time and will, in adverse cases, permit the Department to take such steps as are necessary to finish the work as outlined in the contract.

The weekly report with all spaces properly filled in, including work up to the end of the weekly period, must be sent in promptly. Send 1 copy for each project to the division office and 1 copy on each bond issue project, and 2 copies on each federal aid project to the Jefferson City office.

Whenever a change is rendered necessary by a mistake in plans, a reclassification of materials, or otherwise, the project engineer should make the change on his plans, prepare a change order and submit it at once to the division engineer. On federal aid projects the approval of the federal inspector of such change must be secured; while on state work the approval of the Department's general inspector or of the division construction engineer is required.

A close check must be kept on all construction materials received on the job, so that payments for same can be made as such materials are received and the proper deduction allowed as they are used. Reports on state furnished materials are to be submitted weekly to the Engineer of Materials.

Pay estimates for contractors are to be made monthly and must be accurate in detail and submitted on time. It is important that information in all reports and estimates be correct, as the compilation of such data for statistical purposes is based on these reports and estimates.

General Information

Project engineers and their assistants should refrain from issuing orders or giving instructions to laborers on the jobs. They should talk to the foremen or superintendent first. If that is not effective then the matter should be taken up with the contractor. If this step also fails to secure the desired results, the project engineer should report the matter in detail to his division engineer.

Field men should be very careful about making critical remarks regarding methods and equipment used by a contractor, for unnecessary antagonism is thereby aroused. The Department is interested in securing the desired results and the quality of work called for in the contract rather than in the methods by which results are produced. The project engineer and his assistants are required to watch carefully all materials going into

a job. If the materials are questionable, the matter should be taken up with the testing laboratory, even though a satisfactory card was attached to the car in which they were shipped. Measurements of materials going into batches of concrete should be checked independently of the contractor's men.

The dimensions of forms and the placing of reinforcing steel must be checked, as well as the time of mixing a batch of concrete. Checking should be done with a tape, instrument or watch, as judgment by eye is not regarded as being sufficiently accurate. Project engineers should inspect detours often enough to see that route signs and arrows are up and that the traveled way is in good condition.

Project engineers should keep all their records in a note book and not depend upon their memory. Records should be kept up to date, so that at any time a new man coming on the work can take up his duties without confusion or interruption of the supervisory work. All available cost data should be recorded for future estimating of work. In order to avoid arguments, all orders and instructions should be in writing, especially so when they vary from the plans, specifications and contract.

PAVING BRICK ASSOCIATION TO STUDY POSSIBILITIES OF 2½-IN. BRICK

At the largest and most enthusiastic annual meeting ever held by the National Paving Brick Manufacturers' Association, which convened in St. Louis, at Hotel Chase, January 20, 21 and 22, 1925, steps were taken upon, upon the strong recommendation of paving engineers who addressed the convention, to make a careful study of the possibilities of 2½ in. brick for all street and highway paving designed to accomodate light and medium traffic.

Beginning 14 years ago and increasing rapidly in the last 5 years, there has been a decided tendency in some sections of the country toward a thinner brick on the lighter traffic thoroughfares.

Paving engineers pointed out to the manufacturers assembled that vitrified paving brick today is essentially a pavement wearing surface. The gist of their recommendations was that with the change from steel to rubber tired traffic, abrasive wear on all pavement surfaces has been reduced until now it is a negligible factor in most sections of the country.

The Brick Convention of 1925

The convention, after a joint meeting the first day, divided itself into three groups; owners and executives, field engineers and salesmen, superintendents and operating managers. The general subjects discussed were "Better Construction of Brick Pavements," "Modern Sales Methods," and "Economy in Production."

E. W. James, Chief of Design of the Bureau of Public Roads, U. S. Department of Agriculture, was the principal speaker the first day. He told how federal aid is being administered and pictured the problem which faced the bureau in its early days of thoroughly covering the country with a unified and coordinated net-work of highways with 48 individual states to deal with.

Louis H. Egan, President of the Union Electric Light and Power Co. of St. Louis, was the principal speaker on the second day of the convention. His was an inspirational address dealing with modern methods of selling a quality product to the public.

The 2½ in. Brick

It was in the group meeting of Field Engineers that the recommendation for a survey of the possibilities of the 2½ in. brick originated. The consensus of the engineers who discussed the subject can be summarized as follows:

"In the early days of street and highway paving, traffic was light and the principal aim was to lift communities out of the mud. More often than not vitrified paving brick were looked upon as comprising the entire pavement structure and so used. Occasionally there was a foundation specially prepared of gravel, sand or even planks. At times two course construction was used in which a layer of common brick was put down, a sand bedding course applied, and the paving brick laid thereon.

"As traffic increased in weight and intensity, the first change to take place was toward a more substantial artificial base, except in those sections where sandy or gravelly subsoil provided speedy and perfect natural drainage. There followed a period during which principal attention was paid to designing artificial bases of sufficient durability to carry the loads. The outstanding

exception to this is Florida where it still is modern practice to lay brick on the compacted sand soil.

"Later, it became more and more apparent to highway engineers, at least to a certain large school of highway engineering, that in the last analysis the weight of traffic had to be carried by the subgrade. Dry and stable subgrades never failed to carry the load satisfactorily. All that was needed on such a subgrade was a surface that would resist abrasion and that could conform to subgrade movement.

"This centered attention more on efforts to stabilize subsoils. Research in drainage followed. The result is that today there is a very large school of highway engineers that believes pavement design should start with careful consideration of subsoil conditions and characteristics. After everything possible has been done to stabilize the subgrade with suitable drainage or the admixture of coarse materials to reduce capillary moisture, in many instances artificial bases of comparatively inexpensive material may be found sufficient, this base to be protected by a wearing surface that will withstand whatever abrasive wear there is, and that will transmit weight and impact to the base and in turn to the subsoil.

"With this development in engineering thought has come the viewpoint that a vitrified paving brick wearing surface of 3-in., 3½-in. or 4-in. thickness is in many cases unnecessarily thick, heavy and expensive under present day traffic where proper attention has been paid to other vital features of the pavement design.

"The trend in favor of the thinner brick has grown to the point where one of the principal papers at the recent Good Roads Congress in Chicago dealt specifically with this feature. This paper, read by Willis D. P. Warren, of the engineering firm of Holbrook, Warren & Van Praag of Decatur, Ill., stressed the point that most failures in brick pavements in the past have not been failures of the pavement surface, but usually failures due to faulty subsoil conditions, failure properly to drain or treat the subsoil, failures of the artificial base, or total absence of either adequate drainage or artificial base.

"It was Mr. Warren's belief that money spent in drainage and treating the subsoil could be saved on the artificial base. In other words with the subsoil properly handled a much thinner and less costly artificial base would suffice. He then carried out the thought that with the decided change from steel to rubber tires, a thinner and less costly brick would suffice for the wearing surface.

"It was pointed out to the manufacturers that in those cases where a thinner brick is altogether sufficient, the industry would be doing a distinct public service by saving property owners and taxpayers the extra cost of unnecessarily heavy brick."

With 2½-in. brick pavements now in use as old as 14 years, it is the intention of the industry to conduct a survey of these pavements from the angles of design, construction, and durability.

Filler

Another feature of engineering interest in the convention was the almost unanimous vote in favor of recommending to the manufacturers the elimination of cement grout filler from the specifications of the Association.

Field engineers insisted that asphalt filler, where the proper grade is specified and the proper application accomplished, is by far the best filler for brick pavements. They just as strongly insisted that the cement grout filler, resulting in a rigid slab rather than a flexible slab, has harmed brick pavements more than heavy traffic.

The National Paving Brick Manufacturers' Association at its annual meeting in Pittsburgh, in December, 1921, adopted a resolution declaring its preference for asphalt filler for general use, such preferment, however, being without prejudice to any type of filler which might possess peculiar adaptation to special local conditions. No action was taken at the St. Louis meeting on the recommendation of field engineers that the cement grout filler should be removed from the Association specifications.

RECENT DEVELOPMENTS IN CONCRETE STREET PAVEMENT PRACTICE

By L. S. Trainor, District Engineer, Portland Cement Association, 111 W. Washington St., Chicago, Ill.

Careful attention is now paid to finishing, in concrete street pavement construction, especially at intersections and curbs. While neatly finished work may cost a little more, close attention to the refinements of good curb, a fine level

surface and properly edged joints running in straight lines add greatly to the durability of concrete streets as well as to their attractive appearance. Mechanical finishing machines are being used successfully on many city street pavements; the roller and the rounded edged plank which are drawn back and forth across the pavement; the longitudinal float, rigid forms held firmly in place, better inspection by better informed engineers, all these things are contributing to the making of better concrete street pavement each season.

I desire to call attention to a new concrete finishing roller I saw on display at the 1925 Road Show. This roller differs from that now in general use in that the shell of the roller is made up of a heavy wire mesh instead of sheet metal. This new roller is about 5 ft. in length, 10 ins. in diameter, and the samples on display at the Road Show were the "split" type, thereby permitting rolling on both sides of expansion joint filler at the same time. The outer shell or jacket was made up of a woven wire mesh, using about a No. 10 or No. 12 gauge wire with from ½ to ¾ in. square mesh openings.

The inventor of this roller is a practical Illinois paving contractor and his claims are that with this type of roller a minimum displacement of the mass is effected, at the same time particles of coarse aggregate near the surface are sufficiently depressed to permit finishing with the water float and belt methods.

Influence of Research Work

The test and research work carried out by the United States Government Bureau of Public Roads at Arlington Farms, Va., the Bates Road test by the Illinois Division of Public Works and Buildings, The Pittsburgh Test Road at Pittsburg, California, and the work of Prof. Duff A. Abrams at the Structural Materials Research Laboratory in Chicago, have each had a very marked influence on the design and construction of concrete pavements, the next result of which is, that, many engineers are now actually designing the pavement slab to fit the load that will be superimposed thereupon. Sufficient information is now available that the designer in concrete may produce a concrete of any given predetermined strength if he will apply the fundamentals in the selecting and proportioning of the aggregates, mixing, placing and finishing of the concrete, and it is quite refreshing to note that many of our better informed city engineers are adopting the necessary revisements in their specifications to produce high grade concrete.

At Rockford, Ill.

One very interesting case came to my attention something over a year ago at Rockford, Ill., where certain property owners had filed objections to the acceptance of a concrete pavement that had was convinced that the quality of the concrete was satisfactory and that this pavement would give satisfactory service. He, therefore, arranged to have cores cut from the pavement and subjected to laboratory tests and much to our surprise the average compressive strength of the cores taken from this pavement averaged in excess of 5,000 lbs. per square in. A review was later made of the daily sieve analysis of the aggregates and the reports of the inspector covering the proportioning, mixing, placing and finishing operations, and here again the laboratory principles of proportioning and mixing of the concrete were confirmed and I commend to you the adoption of the Fineness Modulus theory of proportioning aggregates in the concrete work coming under your supervision.

The Fineness Modulus Theory

Briefly stated the Fineness Modulus theory is one whereby a proportion can be determined which will produce concrete of any given strength from any suitable cleaned aggregates, irrespective of the size or gradation thereof.

A complete discussion of this subject is contained in a forthcoming bulletin to be issued by the Portland Cement Association entitled—"Design and Control of Concrete Mixtures."

Longitudinal Joint

The metal central longitudinal joint similar to that used by the Illinois Division of Highways in their concrete roads is now being widely used in concrete street construction and where this joint is intelligently installed its use has been quite satisfactory.

Slab Design

On streets of narrow width, it is quite a general custom to reverse the practice of several years ago by building the slab somewhat thicker at the edge than at the center. This practice has the merit of tending to prevent corner breaks and I am quite convinced that an intelligent application of the theory of designing

pavement slabs as unsupported cantilevers, will eventually eliminate corner breaks.

Reinforcement and Joint Filler

It is almost universal practice in the Middle West to use some types of imbedded steel reinforcement in concrete street pavement and recent tests conducted by the United States Bureau of Public Roads tends to prove the wisdom of this practice. Premolded compressible expansion joint filler is generally placed transversely across the pavement at intervals approximating 35 ft. This joint filler extends through the entire thickness of the slab and is usually so installed as to extend above the finished pavement about 1 in.

After the pavement has been finished and properly hardened the joint filler is cut off flush with or slightly above the surface. On one or two projects coming under my personal observation, a heated iron has been applied to the expansion joint filler which had the effect of softening the asphalt contained in it, thereby permitting it completely to fill the slight irregularities at the surface of the joint and to bring the joint filler flush with the top of the pavement. In other cases traffic is permitted to iron out or pound down the excess joint filler and make a sort of mushroom top over the joint.

Curing the Pavement

I have purposely neglected in the foregoing to say anything whatsoever with relation to curing of the concrete pavement, that I may have an opportunity to place especial emphasis on this most important phase of concrete street construction.

A number of different methods have been tried out with varying degrees of success and while no official publication on this subject has come to my attention, the best information now available indicates that water is the best curing agent. Water may be applied to the pavement in a number of different ways, the most practical of which proves to be first to cover the finished pavement with clean straw to a depth of about 6 ins. and then sprinkle and keep this material continuously damp for a period of from 10 to 14 days.

Other methods of curing which are advocated by some include the application of Calcium Chloride, Sodium Silicate, or a thin paint coat of Tar or Asphalt.

Repair Work

Maintenance and replacement of concrete pavement is a relatively simple matter requiring no elaborate organization or expensive equipment as the work can be done by ordinary workmen of average intelligence. However, intelligent supervision is productive of the best results.

In extremely busy sections where it is impossible to close the pavement to traffic for replacement and repairs for any considerable length of time, either one of two methods is available to the repair department and very satisfactory results have been obtained in either case. I refer to the use of an accelerator incorporated into the mix or the use of an especially prepared cement which has the property of gaining extremely high early strengths. Practical demonstrations have proven that by either of these methods concrete pavement can be safely opened to traffic after 24 hours.

The foregoing is from a paper by Mr. Trainor before the 1925 meeting of the Illinois Society of Engineers.

DEFECTS IN ASPHALT PAVEMENT AND THEIR CAUSES

By R. M. Heine, Chicago Paving Laboratory, Inc., Consulting and Inspecting Engineers, 536 Lake Shore Drive, Chicago, Ill.

A good surface mixture cannot be made from poor materials; likewise an excellent mixture, employing the best of materials, does not alone constitute a good pavement as good workmanship and a suitable foundation are requisites. It is logical, then, to consider first some of the requirements of a good pavement.

Design

The first essential is that the pavement be designed on sound engineering principles; too often pavements fail to give the service expected due to faulty design. Given a correct design, our next consideration is the quality of the materials to be employed.

Materials

The stone should be clean, tough, hard, rough-surfaced and cubical in shape, and well graded. The sand should be clean, sharp, hard, free of clayballs, silt, mica, and other organic matter, so graded as to produce in the finished mixture the mesh requirements specified. The filler should be a good quality lime-

stone, Portland cement, hydrated lime, silica dust, slate dust and the like, so crushed as to furnish at least 80 to 85 per cent passing the 200-mesh standard screen and to be shown by the elutriation test to be impalable powder. Any asphalt meeting the requirements of standard specifications will give good results. Its qualifications as a good binding medium, and not its brand name, is the essential.

Mixing

The temperature to which the materials must be heated will depend upon the amount of cold filler or dust to be added at the mixing platform. For binder, in which no dust is used, the materials are weighed and discharged into the mixer and to this mineral aggregate is added the proper amount of heated asphaltic cement (in a fluid state and not over 350 deg. F.). The binder is then mixed until all particles are uniformly coated with the asphaltic cement and a homogeneous mass is produced. In preparing sheet asphalt mixture, the sand and filler are carefully weighed, discharged into the mixer and then should be thoroughly mixed prior to the addition of the asphaltic cement. Sheet asphalt and asphaltic concrete mixtures usually have a time limit specified for mixing, not less than 1 minute after the addition of the cement being the accepted medium.

The vehicles used to transport the conglomerates to the site of the improvement should be covered at all times to insure the materials reaching the street in the proper condition.

Laying

The base should be uniform as to contour; any major depressions should be filled with binder and the same thoroughly tamped or rolled before proceeding with the regular binder course. The binder is deposited by the trucks in small piles convenient to the shovelers who, in turn, place it irregularly in the designated place. In placing the material, shovelers should turn their tools and tap the point on the base, thus partially spreading the mixture; they should never be permitted to throw the material into position as such carelessness not only gives a certain degree of premature compression to the material thus handled but also causes the aggregates to segregate, the larger particles being thrown out to be later carelessly raked into one position, forming honeycomb spots.

The rakers should take as much care with the binder as with the wearing surface. The surface of the binder after rolling should be as uniform and even as the finished surface. All low spots should be brought to grade; all high spots picked off or pulled down, as a uniformly smooth binder is essential for a smooth wearing surface. No hauling should be permitted on the binder until sufficiently cooled and every precaution should be taken to keep it clean to insure a good bond between the two pavement courses. A good bond between binder and wearing surface is necessary to insure a continued smooth finish to the wearing surface.

The surface mixture is deposited in very much the same way as the binder. Shovelers should never be permitted to get too far ahead of the rakers as this permits the material to cool off too rapidly. Workmen should never walk in the hot mixture; either the shovelers should leave a path for the rakers or the latter should wear pegs on their sandals. Raking should be deep, uniform and smooth, combing all material thoroughly. The backs of rakes should only be used to get final surface.

If only one half of the street is covered by one load, then the unrolled portions down the center and at the end should be covered with next hot material, allowed to reheat for a minute or two and be reraked, thus avoiding honeycombs and depressions in these areas. In no case should the previously raked and unrolled areas be pulled down with the rake as eventually depressions will be formed by traffic.

Rolling may be obtained in different ways. Straight rolling, parallel to the curb, overlapping each time and working from curb towards the center; Diagonal rolling, beginning with straight roll along each curb and diagonal rolling from side towards center; Cross rolling, beginning with a roll along each curb, followed by cross rolling perpendicular to curb and lapping; Serpentine rolling, this being a furthering of diagonal and cross rolling: The latter is probably the best if the crown of the street will permit. All initial rolling should be done slowly and with a heavy roller to give the greatest amount of compression possible. In reversing, roller should be moved quickly but smoothly to avoid leaving a depression.

In making joints the vertical cut appears to be the best method. The old asphalt should be cut with a face per-

pendicular to the base and then lightly painted. Hot material should be piled against and over the cold joint and the latter allowed to reheat. When raked, the joint should show the same elevation as the rest of the newly raked material and never be tapered from the edge. After heavy tamping along the joint, if the roller gets into position parallel to the joint and rolls same an inch or two at a time for a distance of a few feet, a perfect junction between the old and new material will result, with no danger of future depressions or high spots. On narrow streets, the roller should approach on a diagonal.

Along gutters, manholes, car tracks, etc., it is advisable to leave the finished pavement a quarter inch or more high and all such places should be well painted prior to applying the surface mixture. Cement, or other dust which is swept over the finished surface to help fill the smaller interstices, should be applied while the pavement is still warm and then rolled into the mixture.

The best temperature for rolling appears to be between 300 and 325 deg. F. The experienced rollerman tries the raked material with his foot or waits until he can place his hand lightly on the material without being burned.

All honeycomb spots mean a shortage of material and should be treated by troweling in hot material and immediately rolling it. While it is possible for an experienced workman to use a hot smoothing iron for working in new material in such places, the use of irons should be prohibited as only an expert can handle them without burning the wearing surface.

Rolling should be continued as long as there is a possiblity of movement in the pavement and the pavement closed to traffic until it has thoroughly cooled to normal air temperature.

Defects in Asphalt Pavements

An asphalt pavement is the most desirable of all as it is smooth, noiseless, dustless, plastic, has a long life, the initial cost is not great and it is easily and cheaply repaired or replaced. Yet we notice some defects as we examine the surfaces of asphalt streets in various localities and the question naturally arises concerning the causes thereof and in what manner they may be remedied. It is with this question in mind that an attempt has been made to classify them, giving the cause and result.

Waving or Rolling

I. Construction Waves. Formed by improper methods of dumping, shoveling, raking, rolling and tamping.

(a) Dumping. Discharging load with tailgate partially closed. Result: irregular compression.

(b) Shoveling. Placing uniformly in rows instead of irregularly. Result: average raker will pull top of pile over into depression, the mass will not be uniformly raked and traffic will eventually develop waves.

Throwing or tossing into place. Result: material partially compacted.

Not breaking up material as placed. Result: hinders rakers and may leave compacted spot.

Leaving material at bottom of piles undisturbed. Result: compacted area.

Shoveling too far ahead of rakers. Result: permits material to get too cold for good raking.

Not covering up cold, unrolled joints of previous load and allowing to reheat. Result: joints become too cold to get full compression and honeycomb areas may be formed; traffic will eventually form depression so that outlines of loads may be seen.

Leaving dumping spot smoothly cleaned off. Result: when cold, imperfect union between top and binder.

(c) Raking. Lack of deep and uniform raking. Result: leaves material with areas of varying density and compaction.

Too frequent use of back of rake. Result: tops of shovelsful pulled over into the holes, material not thoroughly combed and superficial raking done to give appearance of an even surface. Depressions formed by traffic.

Pulling down of cold, unrolled material at the end of roller mark. Result: raker knows this area will not compress so rakes off surface to make appearance of smooth raking. Area should be reheated. Depressions formed by traffic.

Tapering of loose material at joint. Result: depressions formed by traffic; joint mark conspicuous.

Walking in hot material and not reraking. Result: partial compression; slight bumps eventually.

Covering up of lumps of surfacing material. Result: wavy area.

(d) Rolling. Initial rolling rapid instead of slow. Result: maximum compression not received and asphalt pushes ahead of roller.

Slight pause at reverse. Result: depression.

Lack of cross-rolling. Result: waves in surface which would otherwise be rolled out. Noticeable in narrow streets where cross-rolling impossible.

Lack of sufficient weight of roller. Result: maximum compression not received and movement of surface under traffic made possible; stability of pavement impaired.

Uneven motion of roller. Result: waving.

(e) Tamping. Insufficient compression around manhole frames, water boxes, along curb, etc. Result: depressions formed under traffic.

II. Irregularities in Base. Result: depressions will not receive full compression as roller will bridge them. Depressions formed by traffic. High spots form bumps. All depressions in base should be filled with binder and tamped or rolled previous to applying binder course.

III. Rough or Wavy Binder. Result: uniform, smooth top surface almost impossible. Wavy binder usually means a wavy surface eventually as uniform compression in the surface is impossible.

IV. Bulging of Concrete Base. Due to expansion from heat, moisture or a combination of both. (Before blaming the asphalt, examine the base). Result: decided waves and cracks.

V. Organic Matter Covered by Paving Mixture. Result: bulge or blister may be formed by collection of leaves, pieces of cloth, etc.

VI. Defective Base. Causes: (a) Frozen Base. Result: distintegrates and leaves irregular surface.

(b) "Green" or Uncured Base. Result: if covered with asphaltic mixture and traffic permitted, rupture follows with corresponding displacement of surface.

(c) Lack of strength of base due to depth, materials used, poor mixture, etc. Result: breaking up or cracking of same followed by depressions, waves and cracks in surface.

(d) Defective sub-base. Depressions and holes formed by settlement, washing out, etc., causing bridging of concrete followed by its collapse. Result: depression in surface.

(e) Smooth Base. Result: provides no possibility of mechanical bond between base and binder or asphaltic mixture, with consequent encouragement of creeping of wearing surface.

VII. Disintegration of Binder Course. (a) Water. Result: causes separation of mineral aggregate and asphalt; action is rapid and all asphalt pavements should be provided with excellent drainage, both sub and surface.

(b) Gas. Result: destructive action; causes separation of mineral aggregate from asphalt with formation of tiny pockets of asphalt with retain the gas odor usually perceptible when surface is broken. This action is very rapid and rambling and when repairs are made, care should be taken to remove entire affected area.

(c) Soft Stone. Result: disintegrates and pulverizes when damp; binder goes to pieces.

(d) Dirty Mineral Aggregate. Result: does not permit coating of aggregate and bonding of same; easily broken apart.

(e) Dry Binder. Result: breaks up; no bond between particles.

(f) Burnt Binder. Result: no adhesion between particles; crumbles.

VIII. Disintegration of Surface Course. (a) Water. Result: separation of mineral aggregate and asphalt; destroys stability of pavement.

(b) Gas. (See same heading under Binder).

(c) Oils From Automobiles. Noted especially where continuous parking permitted or at gasoline filling stations. Result: surface softened and ruts formed by vehicles while pavement is in that condition; life of pavement gone in these areas.

(d) Paint Coats. Non-evaporation of material used to cutback the asphalt. Result: mixture drawn up into surface, followed by destructive action; takes life out of the asphalt and causes separation of mineral aggregate and asphalt; noted especially where gasoline is used. All such mixtures should be submitted for laboratory approval prior to use.

(e) Unburned or excess oil from drum burners where direct flame is used. Result: no life in pavement; loss of adhesiveness in the asphalt and no stability in pavement.

IX. Unstable Binder. (a) Lack of sand, especially noticeable where open binder was specified. Result: slight adhesion between particles. Binder brittle, easily broken or displaced.

(b) Poor grading of sand and stone. Result: minimum of stability in mixture.

(c) Excess of Sand. Result: separates stone and lessens stability; does not permit an interlocking.

(d) Excess of Asphalt. Result: lessens stability of mixture and will eventually find its way to the surface of top

course, unnecessarily increasing bitumen content in that portion of pavement and facilitating displacement under traffic.

(e) Dirty Aggregate. Result: does not permit adhesion of asphalt and lessens stability.

X. Unstable Surface Mixture. (a) Sand poorly graded. Result: lessens interlocking action, decreases inherent stability; increases voids; permits shoving, rutting, waving, etc.

(b) Mixture not designed for traffic. (This subject now being given full consideration by everyone interested in asphalt pavements and is the subject of considerable research work. Present tendency is to increase density of pavement mainly by increase of 200-mesh material (thereby reducing voids to a minimum) and use of as hard an asphalt as is compatible for heavy traffic streets. Richardson's grading of sands remains the standard with revision in certain localities and further revision likely. Generally admitted that paving mixtures of the past will not withstand present day volume and weight of traffic, hence necessity for correction of design by specialists in this line of work.) Result: heavy traffic on present day light traffic mixtures causes waving, rutting, shoving, etc. Light traffic on heavy traffic mixtures permits cracking and disintegration account insufficient traffic.

(c) Excess Asphalt. Result: separates particles and does not permit interlocking of same; decreases stability of mixture and is followed by rutting, shoving, etc.

(d) Lack of Filler. Result: low stability, voids not filled to maximum making it impossible to secure proper stability.

(e) Dirty Aggregate. Result: does not permit adherence of asphalt to particles and permits internal movement of individual particles.

(f) Excess Silt, Mica, Organic Matter, etc. Result: all regarded as injurious to pavement. Silt forms small balls or coats larger particles and does not permit adhesion; mica is soft and not stable; organic matter holds moisture and decays with subsequent breaking down at that particular spot.

(g) Overheating asphalt. Result: May split into lighter oils or drive off essential lighter oils and make asphalt brittle.

XI. Lack of Bond Between Surface and Binder. (a) Lack of weight of roller, with consequent low unit compression. Result: after forcing top material into open spots in binder, light roller shears top material from the closed binder, leaving it smooth and with no bond between top and binder; surface of pavement pushes under traffic. (In one instance where 5-ton roller was permitted, three distinct cleavage planes were noted).

(b) Wet Binder. Result: chills lower surface of loose material with possible film of water entrapped, destroying bond.

(c) Dirty Binder. Result: coating of dust or dirt prevents bond between top and binder (same effect noted in resurfacing sheet asphalt).

(d) Cross-rolling on Steep Grades. Result: roller has tendency to side-slip and shearing action follows. Rolling should always be with the grade; surface should cool slightly before cross-rolling permitted.

(e) Dryness of surface mixture and relationship to heat. Result: dry mixture (a mixture not containing sufficient bitumen or dust) is difficult to make adhere to binder unless particular attention is paid to temperature.

(f) Oily Sand or Stone. Result: this is possible where aggregates are exposed to direct burner flame and excess or unburned oil sprays material. In addition to taking life out of asphalt by cutting-back action, it will cause lack of bond; same result noticeable where oil has been dropped in quantity from rollers, trucks, etc.

noted in cold weather and particularly at load joints. Result: unrolled material chills quickly and is not compressed; liable to rut and wave under summer

XII. Honeycomb Areas. Especially traffic.

XIII. Smooth Base. Result: no depressions into which binder can be keyed. Pushing of pavement may follow unless the whole has the maximum of stability.

Causes of Hairline Cracks

1. Dry surface mixture. Result: insufficient adhesion between particles.

2. Rolling while mixture is too hot. Result: fluidity of asphalt does not permit maximum adhesion.

3. Excess of water on roller wheels. Result: sudden chilling plus motion.

4. Lack of bond between top and binder. Result: surface moves with roller.

5. High temperature or presence of fluxing agent (kerosene, etc.). Result: loss of adhesiveness.

6. Twisting of roller on sharp radius. Result: adhesiveness overcome.

7. Diagonal rolling on high crown. Re-

sult: roller exerts uneven pressure and weight is thrown on small area; rocking motion overcomes adhesion.

8. Straight cracks. Result: when roller leaves ridge on first rolling and crosses this at right angles, a fine straight crack is often formed.

Causes of "Fat Spots"

1. Oil in binder or surface material. Due to variety of causes such as drippings from rollers, trucks, excess oil used in greasing truck bodies, etc.

2. Improperly mixed material.

(a) Worn out liners, worn out gate, short mixer paddles, warped mixing box, all permit pockets of asphalt to gather.

(b) Short mixing time prevents asphalt from being uniformly distributed throughout mixture.

(c) One sided mixing, usually due to improper paddle arrangement, resulting in one side of the mixture being dry while the other is too rich.

(d) Overloading mixer box; trying to mix a charge greater than efficient capacity of the box.

"Balling" of Surface Mixture

1. Dense mixture lacking sufficient heat.

2. Excess of asphalt; where high percentage of dust is used, or very fine dust, asphalt content must be reduced. If mixture is at proper temperature, "balling" up indicates excess of asphalt.

Transverse Cracks

1. The majority of such cracks will be found due to cracks in the base.

2. Lack of ductility in the asphalt, and contraction due to temperature of air.

3. Poorly made joints.

4. Burnt mixture; cracks and crumbles.

5. Mixture not properly designed for traffic; traffic too light for mixture design; lack of traffic does not provide sufficient kneeding of mixture.

Pushing to Side

1. Unstable surface mixture on acount of poorly graded sand, lack of dust, or filler, and excess of asphalt.

2. Mixture not properly designed for traffic.

3. Smooth base.

Rutting

1. Soft mixture, usually due to excess of asphalt.

2. Cold joints; noted particularly where loads are dumped parallel on wide street.

3. One track traffic. Often seen between safety zones and curb where surface is not composed of properly designed mixture.

Scaling

1. Excess of water on roller wheels, plus hot mixture.

2. Burning of surface with hot irons during construction.

Drepressions

1. Along rails, due to insufficient compressing during construction.

2. Along rails on curves, due to scouring action of traffic.

3. Failure or sinking of base.

4. Burnt asphalt; gasoline drippings, etc.

5. Poorly made joints.

6. Honeycomb spots, which are always short of material.

It is to be hoped that some mechanical means will be developed in the immediate future to improve our present day methods, especially those in use on the street where a smooth surface is entirely dependent upon the human factor.

GRAVEL ROAD MAINTENANCE

By J. T. Donaghey, State Highway Engineer, State Capitol Annex, Madison, Wis.

Wisconsin is blessed by nature with a goodly supply of road materials of various kinds and quality, none of which are so valuable as its gravel deposits, especially those throughout the glacial district, which covers the eastern and southern portion of the state.

We have over 25,000 miles of gravel roads in Wisconsin; about 5,000 miles of which are what is termed full depth gravel or from 8 to 12 ins. The majority of this is found on the 10,000 mile State Trunk Highway System.

The balance is what is termed light surfacing and from 5 to 8 ins. in depth. This latter in the majority of cases has been built by the local units of government.

Rules for Surface Maintenance

Our experience has taught us that gravel road maintenance must begin the moment the material is in place on the subgrade, and to maintain the surface adequately, the following rules must be followed:

First: Be sure the road goes into winter quarters in the best of condition. Ditches and culverts must be free and open and the surface must be smooth and free from holes and depressions that will hold water. Add gravel where needed at this time.

Second: Go over the entire road (surface and ditches) with a 12 ft. blade grader just as soon as conditions will permit each spring. Move the top inch of gravel back and forth at least twice. This insures removing all holes and depressions permitting the patrolman to begin the season's work with no handicap.

Third: Add new material at all places where the original material has been pounded into the subgrade by traffic. Add new material to the entire surface as fast as the original is ground up and blown away. This will be about ½ in. per year for each 200 vehicles per day travel.

Fourth: Keep a light mulch of fine gravel covering the surface at all times. The patrolman must move this mulch of gravel entirely across the surface once for each 800 vehicles of travel. As traffic increases, the patrol section must be shortened accordingly and the maintenance equipment increased in weight correspondingly.

Time to Do Work

We begin maintenance work early in the Spring just after the frost has left the ground or as soon as the surface is thawed to a depth that will permit working a blade grader.

At this time the gravel surface is somewhat loosened from the frost action and it is possible to cut off the high places and move them to the low places with more ease and more lasting results than at any other time during the season.

The ridge of gravel thrown outside the wheel tracks by traffic is moved in towards the center of the road with the blade grader and naturally fills the ruts, holes and low places.

All large stone projecting is removed from the surface before adding new material.

Material

If additional new material is needed, it must be made available along the roadside during the winter months and added at this time as it will bond much better and more easily than at any other time during the season.

Where new material is needed to fill the holes and low places, use gravel that has passed through a screen having round perforations not to exceed 1 in. in diameter and containing but a small amount of binder.

When the holes and low places have been filled, the entire surface is gone over thoroughly with a grader having the blade set nearly at right angles, until a uniform and even surface is obtained. The blade is then set at the proper angle to shape up the surface to the proper cross section, which should not permit more than a 3 in. crown for a 24 ft. surface. The blade grader or planer is used frequently to keep the ruts filled, assist in compacting the gravel, and smoothing up the whole surface.

Piles of fine gravel for use in maintenance are placed along the road at convenient points outside the ditch line where patrolmen can easily get the material necessary to fill the small holes and defects that may appear from time to time.

The material is delivered to the road by motor truck or on sleighs during the winter months, provided the haul exceeds 1 mile.

If the patrolman has material available along the roadside he can fill the holes immediately in the spring or after a rain and the water standing in the low places will show him better than can be shown in any other way, the exact depth of new material necessary to bring the low places to the proper crown.

The best time to add new material is when the holes or low places are filled with water.

Time to Use Grader or Planer

The best results are obtained with the blade grader or planer early in the season, just when the frost is leaving the surface, or after a rainy period of several days, at which time the entire surface has become so thoroughly soaked and softened up that material moved from the high places will bond readily where it drops into the low places.

Motor trucks are used to good advantage for pulling the grader or planer. An ordinary 3-ton motor truck will pull a blade grader or heavy planer very satisfactorily. This requires an extra man to handle the grader, but the extra expense is offset by this type of equipment being suitable for delivering material to the road.

Motor graders do excellent surface maintenance work, but are not satisfactory for cleaning out ditches. We find a good team patrol will cover a 6-mile section, a motor grader 13 miles, and a motor truck 20 miles. The team patrol is generally the best and cheapest.

Do not be afraid to use the grader or planer during dry weather on a gravel surface. The material thrown out by traffic should be moved in to assist in

filling the depressions caused by heavy traffic and dry weather. All of the material will not remain in the depressions, but enough of it will to warrant the work. We find on those gravel sections where the patrolman keeps moving the surplus fine material back and forth across the surface even though the weather is dry that he invariably has the best riding section.

Scarifying and Reshaping

Hundreds of miles of uneven gravel roads built in the past have been converted into excellent roads for travel by scarifying and reshaping. A roller scarifier or an ordinary heavy grader scarifier pulled by a heavy tractor is used. It is generally advisable to scarify to the entire depth of the gravel or at least to the depth of the deepest holes. Harrow thoroughly with a heavy peg tooth harrow and shape up the surface with the blade grader. The blade should be set nearly at right angles in order to remove the waves and depressions. Remove loose stones from the surface and use the grader or planer daily until the surface is well compacted. Add fine gravel where needed to strengthen the weak places and fill all depressions.

Untreated gravel surfaces that carry an average traffic of 400 vehicles per day or more should be scarified and reshaped twice during the maintenance season. The first time as early in the season as work can be done and the second time about September 1st. We generally have rains about this season, which will assist in bonding the gravel that has been loosened up with the scarifier. The surface will be in much better condition to go through the fall and spring wet season than if the holes and washboarding are allowed to remain.

Surface Treatments

When traffic reaches an average of 300 vehicles or more per day some form of surface treatment should be applied in order to protect the surface of the road from grinding up and blowing away. Up to this traffic there is probably no question but what the addition of the required amount of new material from time to time will keep the surface of the road in very good condition at a lower cost per mile per year than can be done by any form of surface treatment. However, we must consider the material lost annually, which is not less than 300 cu. yds. per mile for an average daily traffic of 300 vehicles, and the danger and nuisance existing from the prevalence of dust.

Calcium Chloride

The application of calcium chloride or any other dust layer that does not form a surface that will serve traffic without the patrolman's constant attention with grader or planer can hardly be classed as a surface treatment. However, on roads carrying not to exceed 400 vehicles per day quite satisfactory results can be obtained by the application of calcium chloride or similar dust layers. The surface must be shaped to the proper cross section and reasonably well compacted before application. It requires an application of from ¼ to 1¼ lbs. of calcium chloride per square yard for the first treatment. Generally a second application must be made about mid-summer, requiring from 50 to 75 percent of the first application, making in all not to exceed 2 lbs. per sq. yd. per season. Calcium chloride is applied by the use of an ordinary lime spreader and one outfit can apply 2 miles or more per day. Calcium chloride does two things; first, it lays the dust quite satisfactorily, and second, it conserves the material on the road surface, not so much as bituminous surface treatments but enough to be recognized as a considerable saving per mile per year. It is, however, a dry weather treatment and works out much better during a dry season than it does if the season is especially rainy. During a rainy spell a surface treated with calcium chloride gets quite sloppy and pits out easily. It also requires constant and regular patrol maintenance.

There is no question but what this treatment is beneficial especially upon those surfaces that are not bonded sufficiently to treat with light tar.

Light Asphaltic Oils

There are certain gravel roads constructed of such material that the surface is always covered with a heavy mulch of fine material that does not stay bonded but for a short time after each rain. On such roads a light oil surface treatment works out very satisfactorily and at a reasonable cost. The surface must be shaped up properly and the oil applied at the rate of about ½ gal. per sq. yd. After the oil has penetrated the fine mulch, it should be moved back and forth with a blade grader the same as untreated gravel would be handled, and must be gone over often enough with the grader or planer to keep it from becoming solid or shiny, at any point. If there is evidence of it becoming hard and shiny, it is well to apply a small amount of fine material

and move it back and forth over this portion of the surface which will prevent such condition. This treatment will conserve the material, prevent dust, and is generally a satisfactory surface for one season. Frequently, however, it is necessary to give a light second application about mid-summer. In this event the cost will be increased to whatever extent is required by the second application. It will not require quite as much material per square yard the second year as the first. However, if no application is made the second year, the surface soon gets in its original condition or worse. In other words, there is no permanent or lasting value in a light oil treatment. The total cost per mile per year, including new gravel and not including patrol maintenance, will range from $400 to $500. This form of surface treatment is generally satisfactory up to a daily average of 800 vehicles.

Light Tar

Where traffic reaches an average of 800 or more vehicles per day, the loss is not less than 1½ in. of surface annually, or not less than 450 cu. yds. per mile. Very few localities have enough gravel available to construct and maintain their roads for a 10-year period unless such material is conserved to the maximum. A loss of 450 cu. yds. annually would in 5 years provide sufficient material for a mile of new road. No community can afford this loss.

Material Used. We use no material in the top 5 ins. of a gravel surface which exceeds a size that will pass a 1 in. round opening. The material is generally crushed and not separated but is all deposited in the same bin and loaded into trucks from a chute in the bottom of the bin. This insures a uniform gradation. The same specifications prevail on all resurfacing of old gravel roads. This costs somewhat more than pit run gravel or gravel crushed to a larger size, but it is worth much more than the difference in such cost, especially where the surface must be scarified frequently.

Preparation for First Surface Treatment. The surface is thoroughly scarified to a width of 200 ft. or more, and to a depth of the deepest holes appearing in the surface, which is generally not more than 2 ins. It is necessary to lap the scarifier one-half in order to get the surface completely scarified, as material of this kind becomes extremely solid under heavy traffic and a once-over with most scarifiers will not produce the desired results.

Immediately following the scarifier, the surface is shaped with a 12-ft. blade grader to a uniform cross-section. The material is sometimes loose and dusty on account of the fine content, and a sufficient amount of time is permitted to lapse for the surface to become well compacted. A good heavy rain will aid materially. The surface is now swept clean with a rotary broom. The sweeper is hauled by a motor truck and leaves quite a windrow of dust and loose gravel, so that a light grader is used to push the windrow out of the way of the sweeper for its second trip. The surface is swept twice, and after the second sweeping the coarser gravel in the surface projects just a little above the rest of the surface, producing practically a mosaic surface. Should there be any dust pockets remaining, they must be cleaned out with hand brooms. Some gravel surfaces may not need scarifying and are shaped up very satisfactorily with a heavy blade grader. This work should be done early in the spring, just as soon as the frost leaves the surface of the road.

Application of Priming Coat. After the surface is swept clean, the tar is applied as follows:

Light tar (T. C. I.) may be applied cold, but better results will be obtained if it is heated to 100 deg. F. The distributor should be thoroughly cleaned before beginning operations and then kept clean. There should be a double strainer on the distributor tank intake in order to exclude all cinders that may be in the tank car as it is almost impossible to secure a tank car of tar without containing some cinders. It is also very necessary to have several extra nozzles so that if one becomes clogged it can be replaced immediately which will permit the distributor to operate evenly. Even distribution is very essential.

The priming coat is applied at the rate of one-sixth to one-fourth gal. per sq. yd. on new surface treatments, and no sand or covering is spread over it. Forty-eight hours or more are permitted to elapse after the priming coat has been applied, during which time traffic irons out the surface in a fairly uniform manner. If the covering must be spread by hand and conditions will permit, immediately following the application of the priming coat the covering for the second coat should be deposited along the shoulder of the road. Be sure that the

windrow of loose dust and gravel left by the sweeping has been pushed clear out over the shoulder with a grader before the covering is deposited along the shoulder as the covering material should be located on the shoulder outside of the edge of the surface treated portion and not be permitted to mix with the loose material swept off the surface.

Depositing the Covering Material. Pea gravel, fine stone chips or clean, coarse, sharp sand is the best material to use for covering, and for a 20-ft. surface it will require about 50 cu. yds. per mile to cover the surface properly. The covering should be deposited in piles of about ¼ cu. yds. each, and 25 ft. apart, and care should be taken that the inside edge of the pile be entirely clear of the outer edge of the surface treated portion for if a thin film of covering opposite the piles should be covered with the second application of tar it would pit out at that point and produce very unsatisfactory results.

The reason for depositing the covering in advance of the application of the second coat is that a certain amount of covering must be applied immediately after the second coat of tar touches the surface, which prevents the tar from running and permits it to penetrate the surface, thereby forming a skin coat and not a mat. The covering if deposited along the shoulder is also available to add immediately in any amount desired to prevent picking up and to cure bleeding.

Application of Second Coat. Should several days have elapsed before the second coat is applied and the surface has become slightly loosened or dirty, it should again be swept lightly to remove any loose material. The distributor is now set to spread about one-third gal. per sq. yd. on a first surface treatment, and care must be taken to have the tar spread uniformly.

Where the covering is spread by hand a number of men (from six to ten) are stationed along the sand piles from 50 to 100 ft. apart. When the distributor is started along the road, the man at the first pile spreads a little less than one-quarter of the covering in his first pile on the width covered by the distributor opposite the pile, doing the same with the next pile and so on. working rapidly. The second man does likewise when the distributor reaches a point opposite his first pile, and so on down the line of men. The first man, upon reaching the point where the second man started spreading, moves ahead of the line of men, beginning a new station the required distance from the last man in line. Handling the covering in this manner permits applying a small amount immediately after the tar touches the surface of the gravel, and, as stated before, prevents the tar from running off the road surface and assists it in penetrating the gravel, which is what is desired. To do this part of the work cheaply and rapidly, on a large mileage, there should be two or more distributors on each job, one being loaded while the other is distributing. There will naturally be a certain amount of time elapse between the loads, which permits the sand spreaders to go back and add sand where needed to keep the tar from running off the surface or to stop picking up. The distance of the job from the supply of tar will, of course, enter into the question. The other side of the road is handled in just the same manner, and the distributor should be so equipped that two strips over the road will cover adequately the width of surface desired.

Extreme care must be taken to avoid spreading too much covering on the second coat until it has had time to penetrate the surface. If too heavy a covering is spread, or if the spreaders are careless and dump full shovels in a place, the result will be that the excessive amount of covering will absorb or blot the tar and prevent it from penetrating the surface and will result in a mat rather than a skin coat. The spreaders should use square point shovels and learn to throw the covering from the shovel in a manner that will produce an even application.

If the weather is reasonably warm penetration will immediately take place and after two hours have elapsed there is very little danger if more covering than is necessary is applied, as the tar will then have penetrated sufficiently so that the excessive covering will not blot the tar. One or two extra men should be kept on each mile for at least a day or two following the second application to apply covering where the surface starts to pick up or bleed, and a small amount of material should be let in about every third pile or this purpose.

Mechanical spreaders may be used, but if used, not to exceed one-fourth of the total covering required should be spread immediately following the distributor, an additional 50 per cent in about two hours,

and the balance as needed to cure picking up or bleeding.

The most practical and convenient mechanical device for spreading sand, pea gravel or stone chips that the writer has seen in operation is in Dane County, Wisconsin. It was designed by the County Mechanic. It will spread evenly at the rate of 20 cu. yds. per mile of 20 ft. width or any desired thickness in excess of that. It is very simple, can be attached to any dump body truck and is not expensive to construct or attach.

Patching the Surface. The patching material is composed of from 15 to 17 gal. of light tar equivalent to Tarvia B, mixed thoroughly with 1 cu. yd. of coarse sharp sand. The material must be mixed thoroughly either by hand or in a mixer, and if it stands several weeks prior to being used after mixing, all the better. The volatile oils evaporate and when thoroughly cured the mixture makes a better patch and will stay in place much better. Patching material mixed the previous year has been used with better results than when used fresh. No more than 17 gal. of tar per cu. yd. of sand should be used even though it is slow in mixing.

Those in charge of maintenance must watch the surface very carefully, especially the first ten days after the surface treatment is applied. If a hole or abrasion appears in the surface the loose material should be swept out clean and the hole filled with patching material. If there are any places that appear loose and do not harden up under traffic, they should be dug out to a depth where solid material prevails, the hole filled and the material well tamped in and given an application of tar, and in a few days covered with a coat of patching material. The patch will soon iron out and become equal to the balance of the surface. The patrolman must be sure to fill every hole just as fast as it appears noticeable to the eye, even though it is not more than the size of a silver dollar.

Outstanding Points

The outstanding points to insure satisfactory results are:

(1) Do not add more than 1 in. of new material during the season in which the treatment is given. In other words if a gravel road is to be surface treated any additions in material required in the line of re-surfacing should be applied the previous season and permitted to compact during the late fall, winter and spring. However, light applications of ½ to 1 in. can be made early in the spring and get good results the same season. This material should be placed before scarifying the surface.

(2) The surface must be well compacted and uniform.

(3) The surface must be swept clean.

(4) The priming coat must be applied immediately after sweeping.

(5) The tar must be uniformly spread.

(6) The covering must be spread evenly, and a little less than 50 per cent of the required amount spread immediately following the distributor, the balance being applied later as required.

(7) If possible to close the road to traffic for 24 hours after the second coat is applied.

(8) The surface treatment must be followed up promptly and carefully by the patrolman or maitenance gang and patching material must be added just as soon as the slightest hole is noticeable on the surface. A well prepared surface should not require more than 7 cu. yds. of patching material per mile per year.

(9) Unless plans are made to patch every hole the moment it appears, it is better not to attempt to maintain a gravel road with this type of treatment.

Approximate Costs

The first tar surface treatment of a gravel road 20 ft. wide will cost from $900 to $1,200 per mile. This includes necessary preparation of the surface, the follow-up maintenance, and the entire patching cost for the season.

Preparing the Surface for Treatment. Where a road has been previously treated by this method, preparation for retreatment is as follows:

Any portions of the surface that are in perfect condition showing no holes, ridges or wrinkles, may be retreated without scarifying or breaking up with a blade grader. Under these conditions 0.2 to 0.3 gal. per sq. yd. should be sufficient.

Those portions that are slightly uneven should be gone over with a heavy blade grader early in the spring when the tar skin coat is inclined to be loosened up a trifle from frost action and weather conditions, pushing the skin coat out to the shoulder of the road with the grader and and following this up with a light blade grader such as is used in patrol work moving the material pushed to the side of the road back and forth across the surface of the road every other day for a week or two. The best results are obtained when the temperature is from 60 to 70 deg. F.

This breaks up the old tar crust and

the grader operations smooth up the surface of the road to a point where it is practically a perfect cross-section. When the surface has become smooth and well compacted by these operations it is swept clean and the covering material placed in piles along the edge. The tar is applied in the same manner as outlined above and generally no priming coat is required. Should the surface require a priming coat it should not be in excess of one-sixth gal. per sq. yd. The coat required for the second year's surface treatment is approximately one-third gal. The third year and thereafter a less amount is required unless additional width is treated.

The application of tar, spreading the covering, the follow-up patching, and everything connected with the work is done just the same as on a new surface treatment.

The Mixing Method. Where the gravel surface contains but little binder and the surface is not well bonded, very good results may be obtained by applying the tar wtihout sweeping the surface. The surface is brought to the proper cross-section with a blade grader and immediately following this an application of one-third gal. per sq. yd. is spread over the full width of the road.

About two hours is permitted to elapse after applying the tar to allow its penetrating the loose surface. However, traffic can pass over the surface almost immediately following the distributor without splashing but little tar on the vehicle due to the fact that it immediately penetrates the loose gravel surface. Two 12 ft. blade graders are now used to move the top ¾ in. of surface over well beyond the center of the road. Immediately following the second grader the distributor applies one-third gal. of tar per sq. yd. on the solid gravel. Immediately following this the graders push the loose material from the other side over to the opposite side of the road and the tar is spread on the other half of the solid gravel. The loose material is now moved back and forth across the road surface three or four times. The blade is set at about a 45 deg. angle in order that it will roll the material along the blade which assists materially in mixing the tar and gravel. When the loose material has been mixed until it is all coated with tar, it is then spread out with the blade grader to a uniform thickness over the surface. Traffic is permitted to use it immediately—in fact, traffic is never shut off on this type of treatment. A light grader or planer is used continuously until the surface is thoroughly ironed out and well compacted which will take about two days where travel reaches a thousand vehicles or more daily. Where traffic is less than this amount it will take slightly longer to iron out and become well compacted.

After the surface is well ironed out a seal coal coat of about one-sixth gal. per sq. yd. is applied, followed immediately with a very light covering of pea gravel. The planer is again put in operation and mowes the surplus pea gravel from the high spots to any depressions in the surface, resulting in a very uniform and smooth surface within a week or less.

This method requires about five-sixths gal. per sq. yd. and, of course, necessarily costs more than the ordinary surface treatment heretofore described. However, it insures a penetration of approximately 1 in. and also insures the entire surface being well bonded with tar. We find this type requires much less patching and less attention than the ordinary surface treatment. We tried out a mile of this type in 1923 and it came through the 1924 season without a retreatment. Therefore, at the end of the two seasons it was cheaper than the ordinary surface treatment.

We are very much sold on this latter type and are satisfied that more of our treatments will be along this line from year to year.

We surface treated 200 miles of gravel with light tar in 1924, and expect to treat 400 miles in 1925. Dane County alone will treat approximately 200 miles in 1925. After three years' experience in Dane County with tar surface treatments the county board appropriated $150,000 as a special fund for the surface treatment of their main gravel roads in 1925.

It may be interesting to know that Dane County is one of the few wealthy counties in Wisconsin that has not bonded for concrete roads. While I am satisfied that their main roads should be of some highway type of surface, nevertheless they are getting excellent results with the surface treated gravel and are satisfying the general public and especially the farming public. The maintenance cost is well under the interest on a high type surfacing and as long as it remains at that point it can be argued that there is no waste of public funds.

In Wisconsin we find it practically impossible to get appropriations sufficient to build all our main lines of travel with high type surfaces, and we do find that

we can maintain our gravel surfaces in a very adequate manner with light tar surface treatments giving the public a safe and pleasant road to drive and conserving our local materials by so doing until such time as funds may be provided or a high type surface.

The foregoing paper by Mr. Donaghey was presented at the Eleventh Annual Conference on Highway Engineering at the University of Michigan, Feb. 16, 1925.

SOME ECONOMIC POSSIBILITIES WITH ATLAS LUMNITE CEMENT

By J. W. Hussey, The Atlas Lumnite Co., 134 S. La Salle St., Chicago, Ill.

During the past year, the economic possibilities of Lumnite Cement aroused the interest of the engineering profession, as perhaps has no other material for many years. Certainly the reception accorded it by engineers and contractors has been most gratifying to the manufacturer. The use of this cement has spread rapidly, not only geographically but also into many fields. Practically every day a new use for the material is developed.

Properties

Lumnite Cement has several rather unique properties. It has all of the desirable properties of other hydraulic building cements and in addition will develop a much greater strength in a very short period of time. Tests made in many laboratories have conclusively demonstrated that the strength of concrete or mortars made with Lumnite Cement is considerably greater at 24 hours than the strength of concrete or mortars made with portland cements at 28 days.

Some engineers state that the strength of Lumnite Cement at 24 hours is at least 60 per cent greater than that of portland cement at 28 days and at 28 days approximately double that of portland cement at the same age.

It is not a quick setting cement. It is slow setting, allowing ample time for mixing, transporting and placing in the forms. After it has set the hardening proceeds with great rapidity, developing a very appreciable strength in much less than 24 hours. As an indication of the rapidity of this development of strength, the following compression test results are quoted:

Age in hours	Strength lbs. per sq. in.
14	2334
16	2461
18	2593
20	2861
24	3138
36	3267

These results were obtained by a commercial testing laboratory in testing 6x12 in. cylinders made on a job from 1:2:4 concrete sampled at the mixer.

Lumnite on Highway Construction

Highway engineers have been quick to appreciate the advantages of the high early strength of Lumnite Cement. The highway commissions of almost every state east of the Mississippi and many west of that river are using or have approved of the use of Lumnite Cement in highway construction and maintentance. The construction of highway intersections with Lumnite Cement eliminates expensive bridging and reduces inconvenient detours to a minimum. Bridge decks and approaches are constructed with Lumnite. Culverts made with Lumnite can be subjected to load within 24 hours. Broken concrete road slabs are replaced or repaired with Lumnite Cement.

Municipal engineers have been quick to appreciate the value of Lumnite and they are using it to close street openings, build catch basins, construct pavements at street intersections, and grout granite block and brick pavements.

Street car companies are using Lumnite not only to replace pavements along their right-of-way, but also to concrete-in their ties and track and to repair their road beds at broken joints.

Other Uses

The advantages of the high early strength of Lumnite Cement are not confined to highway work. Railroads are using Lumnite in the construction of bridges, repointing of masonry, building of bridge piers, bulk heads, marine piers, bridge seats, turntables and various other structures where the saving of time is an important consideration.

Industrial plants have found that Lumnite Cement is an ideal material because of the saving of time in the repair or construction of a floor, the erection of a foundation for a machine, or the construction of a roadway. Oil companies are using it to cement oil wells, for it permits the resumption of drilling within 24 hours instead of waiting from 14 to 20 days for other cements to harden. In the structural field, engineers have found the unique properties of Lumnite an advantage. It is being used in concrete piles, foundations, floors of buildings, bridges, and other parts of structures.

Not long ago the Bureau of Yards and

Docks of the U. S. Navy provided for the use of Lumnite Cement in the specifications for a sea-plane runway. Under these specifications where Lumnite Cement is used, a mix of 1:2:4 instead of 1:1½:3 is permitted. Concrete piles made of Lumnite Cement are allowed to be driven at three days instead of 30 days. Further the protective coating of asphalt required for portland cement piles was eliminated where the piles were made of Lumnite. The specifications required only 12 hours' protection from sea water after pouring as against 5 days' protection for portland cement concrete. And finally the specifications permitted the placing of Lumnite Cement concrete at 25 deg. F. as against a minimum atmospheric temperature of 35 deg. F. required for portland cement concrete.

Last summer in Philadelphia, the Underpinning and Foundation Company subjected concrete underpinning piers made of Lumnite Cement to full load at 14 hours.

In the construction of a reinforced concrete bridge at Wilkes-Barre, Pa., the McLean Contracting Company drove 18 in. octagonal concrete piles made of 1:2:4 Lumnite Cement concrete when approximately 24 hours old, without any shattering or damage to the piles.

The Schuster Engineering Company used Lumnite Cement in the construction of the upper eight floors of a 15-story apartment hotel at 78th Street and Park Avenue in New York City. Forms supporting these concrete floors were removed at the end of 24 hours. A hoisting engine was erected on a Lumnite Cement concrete floor in this building 24 hours after pouring the concrete and put in operation when the concrete was only 48 hours old.

Cold Weather Work

Another direct result of the rapid hardening property of Lumnite Cement is its use in cold weather. Lumnite Cement develops its strength so quickly that even in the coldest weather it only requires protection for 24 hours and during this period, the cost of protective material and labor is inconsiderable compared with that required by other cements. In moderately cold weather much less protection is required. The rapid hardening of Lumnite Cement, a chemical action, is accompanied by the generation of considerable heat and if the temperature of the concrete is kept above freezing for a few hours or until the hardening of the cement begins, the heat developed within the concrete in moderately cold weather will be sufficient to permit the cement to harden without additional protection.

So far consideration of the economic possiblities of Lumnite Cement has been limited almost entirely to what has been done or is being done. As the use of the cement increases, additional advantages are developed which together with further investigations of its properties are indicating even greater economic possibilities than those now accepted.

Lumnite Cement has been on the market such a short time, its resistance to the chemical attack of sea water and alkaline sulphur bearing soil waters has not been definitely established. However, similar cements have been successfully used for these purposes in Europe for a number of years. In fact the development and production of alumina cements in Europe is the result of a search for a hydraulic cement that would resist the chemical attack of sea water.

It is felt that at least partial recognition of this property in Lumnite Cement has been given by the U. S. Navy in the specification referred to earlier in this paper, in that it is not required that piles made of Lumnite Cement concrete be given a protective coating. Very complete tests are being conducted by the U. S. Navy, the U. S. Department of Agriculture, and in various laboratories definitely to determine the value of Lumnite Cement in sea water and impregnated soil waters.

Test results recently reported by Columbia University give an average modulus of elasticity of 4,808,000 lbs. per sq. in. An investigator in Germany has reported the modulus of elasticity for similar cements made in Europe as approximately 5,000,000 lbs. per sq. in. These values are about double the modulus of elasticity of portland cement concrete.

The modulus of rupture of Lumnite Cement concrete as determined from 4x4 in. test pieces over a 16 in. span is reported by Columbia University as 856 lbs. per sq. in. One of the state highway laboratories has obtained average moduli of rupture at 24 hours of 944 lbs. per sq. in. and at 21 days of 1,112 lbs. per sq. in. These results were obtained in testing beams 6 in. wide, 8 in. high over a 24 in. span. The concrete was a 1:2:3 mix. These values are about double the moduli of rupture of portland cement concretes.

The testing laboratory of one of the railroads has obtained results showing

the strength of bond of Lumnite Cement concrete to reinforcing steel as about 800 lbs. per sq. in. Columbia University reports that in testing the strength of bond to steel, the average bond stress at first slip was 599 lbs. per sq. in. and the average ultimate bond stress was 694 lbs. per sq. in. Again these results are approximately double those for portland cement.

Should these values of Lumnite Cement concrete be accepted some very radical changes in the design of reinforced concrete would follow making possible even greater economic values than those now obtained from the present use of Lumnite Cement.

The foregoing is from a paper before the 1925 meeting of the Iowa Engineering Society.

EXPERIENCE WITH THE COUNCIL-MANAGER PLAN AT DUBUQUE, IOWA

By O. E. Carr, City Manager, Dubuque, Ia.

The Council-Manager Plan of Government became effective in Dubuque on April 12th, 1920. The new administration found many of the municipal funds for the current year already exhausted. It was necessary to map out an economical policy and adhere to it. A saving of $2,500 per month was immediately affected by the abolishment of unessential positions. A total of $300,000 of delinquent taxes, largely special assesment charges, was collected.

A Police Court Judge was appointed. Police Court costs and fines for the five year period previous averaged $1,371. The first year under the Council Manager Government netted $12,562 in fines and costs and last year they amounted to $18,209.78. This does not mean that crime has been on the increase in Dubuque. The contrary is true.

A modern accounting system was installed at once. Out of the confusion has emerged system and records. Today the city can strike off her balance sheet at any time the same as any modern efficient business.

The city opened a municipal garage. In 1922 an unnecessary fire hall was sold and with the proceeds a complete, modern garage was erected, in which is housed all the motor equipment of the city. In 1920 the city hired teams to clean the streets. Six municipal trucks now do the work of 18 or 20 teams.

The city has no Health Department. Now the city and county are co-operating under a trained, full time Health Officer.

The City Hall has been allowed to deteriorate in expectation of a new building, certainly badly needed. The Council-Manager administration found that the old city hall bonds, issued in 1852, had not yet been paid and had been refunded three times, so a furnace and electric lights were installed and the old building will be made to serve until the finances of the city warrant a modern structure.

Duplication of street names has been eliminated.

The numbering of houses in the city has been systematized.

Every department of the city is giving increased service.

Storm sewers have been installed in streets prior to paving. This is a new procedure in Dubuque.

Over 25 miles of streets have been paved, with another 8 miles on the program for 1925. The people are so well pleased with the cost and character of new pavement that petitions are constantly coming in for other streets to be improved.

Each year miles of sanitary sewers have been laid until now there is almost no section of the city which is not served with this convenience.

The city has steadfastly followed a policy of reduction of fire hazards and has improved her ability to cope more efficiently with the fire menace. The improvements in the distributing system of the Water Department were made with this end in view. The increased storage capacity of water, accomplished by the covering of a large storage reservoir here, was another feature toward this end.

An entire reorganization of an inefficient Fire Department was made. Better fire fighting equipment has been secured with the idea that better fire insurance rates would be secured. A detached fireproof building was constructed for use as a fire alarm station in 1922. The average fire loss for Dubuque for nine years previous to 1921 was $275,373 per year. The average loss for the last three years has been $45,448.04 per year, giving a reduction of $230,000 per year in fire loss.

On the first of April, 1924, Dubuque's first building code went into effect. This was the last thing necessary to secure for the city more favorable insurance rates. Effective on April 1, 1924, a reduction of insurance rates in the city of Dubuque

was made, Dubuque passing from the fifth to the third class, in accordance with the classification of the Iowa Rating Bureau.

The improved conditions and the improved service is again reflected in the reduction of insurance rates which amounts to $60,000 per year on the insurance privately carried, Dubuque rates being as low as those of any city in the state of Iowa.

In spite of the large number of municipal improvements carried on since 1920, the indebtedness of the city has been reduced. Every effort is being made to clean up the old tax propositions which not only help the city's finances but also clears up the clouds on titles to much property in the city.

Bonds that are issued are serial bonds. Maturities are so made as to make it possible, without undue and unusual tax levies, to meet the obligations when they become due. In accordance with the present financial policy the old bonds which come due in 1936 and 1937 will be paid off instead of being refunded as has been the case since the original indebtedness was incurred. Dubuque has called in and paid off $93,000 of these old debts in advance of their maturity. These bonds bore a low rate of interest and were called in below par, thereby saving $1,945 on the principal and $47,550 on the interest that woud have been paid prior to their maturity.

Taxes have been reduced. The tax levy for city purposes in 1919 was 62 mills while in 1924 the city levy was 56 mills. At the same time the miscellaneous revenues of the city have been increased from $19,760 in 1919 to slightly over $100,000 in 1924.

Over 20 miles of water mains have been laid, improving the distributing system and making water supply available for all those parts of the city where a real demand has existed.

Development of Dubuque has been retarded on account of scarcity of industrial property. In order to meet this situation and in order to take care of an unhealthy and unsightly condition, the city acquired slough property and filled it is at a cost of something like $150,000. This property now consists of about 30 acres and is available for industrial purposes. A part of the land has already been sold. The city is not desirous of making a profit on this ground but wishes to dispose of it at a reasonable price and in that way encourage municipal development.

It is not possible in this brief summary, to cover all of the changes which have come to Dubuque with the adoption of the new from of city government.

The city is a business. Last year Dubuque's business total $1,897,974.08.

Many of the wastes incidental to administration have been eliminated. City betterment is slow betterment. There are many obstacles, particularly legislative restrictions, which do not harass a private concern. In figures, the present worth of Dubuque is $710,143.25 more than when the Council-Manager Plan was adopted.

The most outstanding accomplishment of the present administration in Dubuque cannot be measured by money saved nor by service increased. It lies in the feeling of confidence in the administration which has developed in the minds of the citizens.

There have been three elections since the adoption of the Council-Manager Form of Government. The first election took place in March, 1922. Opponents fought the City Manager Plan as the issue of the campaign, but they failed to put a candidate in the field. In this election the entire campaign expenses of the re-elected councilmen amounted to approximately $30.

An election was held in 1923 to vote on a bond issue to finance water works improvements and main extensions. The opposition comprised the same forces as in 1922. The City Manager Plan was the issue rather than the passage of the bond issue but the election carried by a vote of three to one.

In March, 1924, a city election was held for the election of two members of the City Council. This furnished an occasion for the same opposition as at the two previous elections. This time the opposition changed tactics. They proposed to go in for a personal campaign with "Get the Manager" as their slogan. They succeeded in putting candidates in the field. The campaign was fought, not with the Council Manager Plan as the issue, for both sides advocated the plan, but with the Manager as the issue. Again the opposition lost, two to one.

The plan in Dubuque has made good. Indications are that there is no considerable number of people who do not see the advantages of the Council Manager Plan as compared to the old Federal Plan. It would seem, at this time, that any contests the administration will have in Dubuque in the future will be contests

regarding policies and not contests for or against the Manager Plan. The plan has sold itself to Dubuque citizens. This fact alone indicates wonderful advances in local government.

The success of a business is primarily dependent upon the way its financial affairs are managed. The ultimate success of municipal enterprises, including service rendered, benefits conferred and low taxes, is dependent primarily upon the way municipal finances are handled.

In June, 1920, Dubuque had $350,000 cash in the bank drawing less than 2 per cent interest, credited to special improvment fund. There were outstanding and subject to call bonds against these special improvements bearing 5 per cent interest. The bonds were called in and the money was paid out. By this transaction the city benefited to the extent of over $10,000. This same transaction might have been made under the Federal Plan of Government, but it was not done. It is less likely to happen under the Federal Plan for the reason that there is seldom any one person who is close enough to all the details involved to pick up the loose ends and see the entire financial field.

Other cities have made greater fiancial blunders. In 1921, when prices were the highest, the city of Des Moines purchased the privately owned water works plant serving that city. Approximately four and a half million dollars worth of bonds bearing 5 and 6 per cent interest and maturing in about thirty years were sold to finance this purchase and necessary improvements. In 1921 interest rates were the highest kown for a generation. Had this obligation been financed through the issuance of short term bonds, say for four or five years, or through callable bonds and refinancing at this time or next year, it would have meant a saving to the water users of Des Moines of between $25,000 and $30,000 per year for a period of at least 25 years.

Such a method of financing was in vogue at the time the Des Moines bonds were issued by practically all industrial enterprises requiring to be financed at that time. The proposition of saving the next generation in Des Moines part of their water bill was not given favorable consideration by the Des Moines Water Works Board.

At no time since 1914 has the Council-Manager Plan been spreading with the same rapidity as it is at the present time. St. Joe citizens have prepared a Council Manager Charter and this week sent the same to the Missouri Legislature for approval. In February, Kansas City, Mo., votes on her Council Manager Charter. Likewise in March Seattle, Wash., votes on a Council Manager Charter.

At the present time 21 cities have openings, immediate or prospective, for City Managers. These cities vary in size from Winter Haven, Fla., with her 2,000, to Cincinnati, Ohio, with over half a million population. The problem in all these cities is to secure the right man to look after administration details.

The eleventh annual meeting of the City Managers' Association was held in Montreal last September. At that time a Code of Ethics for City Managers was adopted by our association. To give a further insight into the ideals of the Manager, I am repeating this Code of Ethics.

Code of Ethics for City Manager

1. The position of City Manager is an important position and an honorable position and should not be accepted unless the individual believes that he can serve the community to its advantage.

2. No man should accept a position of City Manager unless he believes in the Council Manager Plan of Government.

3. In personal conduct a City Manager should be exemplary and he should display the same obedience to law that he should inculcate in others.

4. Personal aggrandizement and personal profit secured by confidential information or by misuse of public time is dishonest.

5. Loyalty to his employment recognizes that it is the council, the elected representatives of the people, who primarily determine the municipal policies, and are entitled to the credit for their fulfillment.

6. Although he is a hired employee of the council, he is hired for a purpose —to exercise his own judgment as an executive in accomplishing the policies formulated by the council, and to attain success in his employment he must decline to submit to dictation in matters for which the responsibility is solely his.

7. Power justifies responsibility and responsibility demands power, and a City Manager who becomes impotent to inspire support should resign.

8. The City Manager is the administrator for all the people and in performing his duty he should serve without discrimination.

9. To serve the public well, a City

Manager should strive to keep the community well informed of the plans and purposes of the administration, remembering that healthy publicity and criticism are an aid to the success of any democracy.

10. A City Manager should deal frankly with the council as a unit and not secretly with its individual members, and similarly should foster a spirit of co-operation between all employes of the city's organization.

11. No matter how small the governmental unit under his management, a City Manager should recognize his relation to the large political subdivisions and encourage improved administrative methods for all.

12. No City Manager should take an active part in politics.

13. A City Manager will be known by his works, many of which may outlast him, and regardless of personal popularity or unpopularity, he should not curry favor or temporize but should in a far-sighted way aim to benefit the community of today and of posterity.

The foregoing is from a paper by Mr. Carr before the 1925 meeting of the Iowa Engineering Society.

THE USE OF HIGHWAYS BY MOTOR TRUCKS

By J. B. Wait, Manager Des Moines Branch, Mack-International Motor Truck Corp., 1122 Mulberry St., Des Moines, Ia.

The motor truck is one of the greatest giants of commerce and one of the least understood. It seems to be treated like a child that has grown too rapidly and has gotten beyond the control of its parents. Because it is impossible to curb by physical force the strength of this giant, drastic laws have been set up with the hope of alleviating what is commonly called its destructiveness to our highways. If motor trucks had been invented before steam locomotives, we would have built good roads capable of sustaining heavy traffic. The advent of the railroad would have displaced the truck for long hauls, and today we would probably be boosting for railroads instead of good roads and truck service for short hauls.

I wish to state at the outset that I do not pose as an expert on motor transportation as related to its use of the highways. The experience of the company of which I am a part necessarily predisposes us toward the view of the manufacturer so far as the vehicles are concerned, and of the layman in the matters of road construction and legislative control. I have but two propositions to advance and in support of them I wish to venture a few paragraphs which come as a result of some little study of truck manufacture and sale in all its phases. These two propositions are these: First, there is a definite need for heavy motor transport on the highways. Second, the cost of creating and maintaining these highways insofar as it is accomplished by a tax in the nature of a license or a usage tax, should be based upon the relative dertiment to the highway caused by the various types of vehicles.

In order to form in our minds a picture of what lies before us in the way of motor transportation, and especially motor trucks, it might be advisable to make a few comparisons. Last year there were registered in this country over sixteen million motor cars and over two million motor trucks, and these two million motor trucks carried in tonnage an amount almost equal to that of our railroads. Taxes paid by these motor vehicles, including the accessories thereon, federal state, and municipal, amounted to over $500,000,000, of which over $170,000,000 went to the federal government, approximately $310,000,000 went to state governments, and over $20,000,000 to municipalities, or nearly half the total sum expended by federal and state highway departments for paved roads. The figures which I have given you do not include approximately $75,000,000 paid in personal property taxes on motor vehicles, nor over $2,000,000 paid in federal tax on motor vehicles for hire. Few of us realize that today there are more motor vehicles in operation within the boundaries of the United States than there are telephones, or that the motor vehicle industry ranks second, if not first, in dollars of gross sales, and that an enormous amount of the value of other industries enters into the product of these motor vehicles.

At a time when the long-distance national need for more and better highways is being substantially met by legislative appropriations in the hundred million dollar figures, it seems appropriate to ask the question: "What has made this huge expenditure possible and in what terms will the dividends from the investment be expressed?" It seems appropriate further to consider what is the basic idea behind this expenditure—who pays for these highways, for what purpose are

they built, and who benefits by them?

Two classes of motor vehicles use our highways—the motor truck and the passenger car. About 10 per cent of the people in the United States own passenger cars, yet through the medium of the motor truck, every person in the country is directly benefitted by the money that is spent for building highways. As a matter of fact, if the sixteen million people who own passenger cars were the only ones to derive benefit from the road, our government would scarcely be justified in spending for this purpose money which comes from the entire one hundred sixteen millions. But since practically every article that is consumed or used by everyone in this country makes some part of its journey from producer to consumer in motor trucks, the entire population receives a dollars and cents return in the form of lower living costs, from the improvement in transportation which motor trucks and good roads make possible.

Adequate transportation is essential to general welfare and properity, and as conditions exist in the United States today, adequate transportation is impossible without the use of the motor truck. For example—suppose every motor truck in the country was suddenly put out of use. It would cause a paralysis of the railroads though inability to clear terminals; it would mean cessation of practically all building operations through lack of materials; it would stop practically all passenger automobile operation as almost all gasoline and oil is transported to retail filling stations in motor trucks; it would tie up retail business in large cities to nearly a standstill and countless other situations equally serious would result. It is a fact that the average person does not realize how dependent he is upon motor transportation.

Good roads must be built if the country is to profit to the largest extent by the economic advantages of the motor truck, and if we are to have good roads then road financing must be placed on a sound economic basis. It is quite natural that the task of collecting and disbursing funds for supplying good roads should be undertaken by government in behalf of the people, since it is a national proposition and since there is no other agency large enough to handle the problem efficiently. It is a business arrangement, pure and simple—the original investment comes from the people of the country as a whole, while the upkeep and maintenance of the roads is paid for by the vehicles that use them in accordance with the amount of road wear each causes. The latter is, of course, a just arrangement under any conditions, yet the former—the investment on the part of the entire population of the country— is only justified through the use of the motor truck which gives each investor a return on his investment. In fact it is only through the increasing use of the motor trucks that an enlarged road building program has been justified and consequently possible.

Recent legislation stimulated by automobile owners has, in some instances, sacrificed the motor truck in the interest of passenger cars. It is obviously important that passenger car owners realize that if they are to have improved highways over which to travel, the expenditures for the roads must be economically justified and since the motor truck is the factor which makes such expenditures justifiable, the automobile owner who attempts to hinder the growth of motor truck transportation, defeats his own purpose which is to secure good roads. Even now I understand there is a bill pending before the Iowa Legislature sacrificing the motor truck to the passenger car; a bill calling for a reduction in the license fees on passenger cars and increasing those on motor trucks.

The fact that the motor truck is entitled to favorable consideration in framing laws for highway regulation, does not mean that it should not be carefully governed. Every vehicle using the roads should pay for the road wear which it causes. This fact has long been acknowledged by all concerned with legislation pertaining to highway transportation. But as yet no law has been framed which will accomplish this end. The reason for this has been the lack of knowledge of the factors which enter into road wear. Recently, however, tests have been conducted at Washington which established a definite and workable basis for road conserving legislation. These tests show that vehicle design insofar as it governs the proportion of sprung and unsprung weight is the most important controllable factor in road wear.

Now comes the question, "What is Road Wear?" We might say that road wear is the impact on the road caused by the gross weight of the vehicle using that highway, and naturally following is the question, "What is Road Impact?" If you take a big, wide-faced, sledge ham-

mer, swing it over your head and come down with all your force in the middle of the road—that's impact.

Now let us take this same sledge and fasten a light buggy spring to the upper end of the handle and on top of the spring fasten a brick. Now swing the whole combination over your head once more (if you are powerful enough) and let it strike the road just as you did before—what happens? The brick rebounds on the spring. That is sprung weight or weight supported by springs, and the sledge hammer beneath the spring is unsprung weight or dead weight.

Now to the government test: By weighing separately each rear wheel of a 3-ton worm driven truck loaded with 5 tons of sand, you will find that each rear wheel supports 7,750 lbs. and that 1,837 lbs. of this amount is unsprung weight, or the sledge hammer part of the load.

When this 3-ton loaded truck, running at 15 miles per hour, drops into a 2-in. rut, the impact or sledge hammer blow is 34,500 lbs. or approximately 17 tons.

Following the above test, the government officials tried out a chain driven truck of 5½ tons capacity, carrying a load of 5.65 tons, and found, although it was of 2½ tons greater capacity, that due to its axle construction, having no heavy gears enclosed in heavy steel axle casings like the worm driven axle, it only had 1,000 lbs. unsprung or sledge hammer dead weight and the blow or force of impact over the same improvised rut amounted to only 23,500 lbs. (or a little less than 12 tons) as against the 3-ton worm driven truck that showed a road impact of 34,500 lbs. (or slightly more than 17 tons).

These were but a few of the exhaustive tests recorded, but they are enough to prove to every intelligent citizen that indifference to such subjects is costly and each of us pays for his share of errors simply because we stand back and "let George do it."

If the 5½ ton chain driven truck shows officially that it gives only 68 per cent of the destructive unsprung sledge hammer blow to the roadbed that its competitor, the 3-ton enclosed drive truck gives, the tests which are now being prepared for 7½-ton chain driven trucks (if the simple law of proportion is still a law) will show that if there is any "road legislating" to be done against trucks and any restrictions enacted it should be upon the basis of destructive road impact or unsprung dead weight carried.

As a last proof of the tremendous importance of supporting every pound possible upon well made springs, we have removed the brick and have placed the spring under the sledge hammer. The sledge now represents the load on top. If you place a healthy hickory nut upon the road and swing the sledge (spring down) with all your might, the impact or force of the spring against the hickory nut would hardly be great enough to crack its shell. If you reverse the order again and hit the nut directly with the sledge, you know what would happen to the hickory nut.

I, therefore, repeat that if we must legislate against any form or class of carriers, let us legislate against the one that embodies the greatest number of direct sledge hammer blows built into its rear axle. On the other hand, rather than squabble over road impact at all, or any other feature that will prevent or even retard the advance of commerce, let us insist upon roads, not for today's traffic, but for tomorrow's.

It has been repeatedly proved that motor transportation costs decrease as the unit load or capacity increases. The known advantages of large capacity trucks are in danger of being sacrificed, however, to the popular misconception that only heavy duty vehicles are destructive to roads. As jurors upon this case, let us see to it that the unbiased conclusions reached by the Engineers of Public Roads Bureau receive the consideration to which they are entitled.

Should not legislation be so framed as to favor large highway transportation units of this kind in order that our highway system may have the greatest possible productivity? In view of the fact that these units not only decrease road wear but also lessen road congestion and reduce the possibility of accident by their more moderate speed, there would seem to be but one logical answer to this question. Speaking broadly, we have not as yet been able to eliminate even petty politics from our road making plans long enough to work out a scientific and embracing national scheme of highway construction. Certain towns and localities are favored overmuch, and continue to be favored. The butter is not spread evenly upon the bread, and little transportation progress is made.

That the motor truck is having and must have a place on our highways must be apparent to us all. That the legisla-

tive tax must be based upon the relative damage a vehicle does to the highway also would seem sensible and fair. The application of the latter principle is easy of statement but different of application. It is my judgment, and I advance it with diffidence, that the tax or license should be based not only upon the weight per inch width of tire, but also upon the unsprung load carried by the vehicle. This can be determined by scientific tests and a standard adopted which will serve in all classes of cases.

The foregoing paper by Mr. Wait was presented at the 1925 meeting of the Iowa Engineering Society.

SPECIFICATIONS FOR A RESPONSIBLE BIDDER

By Geo. H. Jennings, Vice-President, Powers-Thompson Co., Joliet, Ill.

Constructive criticism of what has been done in the past will do much toward eliminating the irresponsible bidder and we will, therefore, devote considerable space to the discussion of defaulted contracts and their causes.

There are several reasons why contractors fail, the principal of which are as follows:

1. The low bid is most frequent of all.
2. The lack of finances.
3. Lack of organization.
4. Lack of equipment or means to procure it.
5. Lack of knowledge and experience necessary properly to carry out the contract.

Taking the causes in the above order, we will discuss them one at a time. The low bid being the most fequent and greatest of them all, we will handle first.

The Editor Is Flattered

At the Short Course held at Elgin last year, I read an article that I cut from Municipal and County Engineering several years ago. I feel that I should read this once more, and offer apologies to all those, who were present at Elgin. The editorial is entitled "The Low Bid" and reads as follows:

The Low Bid

"The contracting business is sorely afflicted with a custom. This custom is a blight, a killing frost, a curse. In parliamentary language this troublesome agency is called the low bid. The low bid is one of our cherished institutions. It is lovely in theory. In practice it is as a monkey wrench hurled into the machinery of construction. Everything would be lovely if it were not for the fact that a fool is born every minute and that an amazing number of them, born into the contracting business. Knowing nothing whatsoever about costs, they keep bidding until they are decidedly low on some job. Owing to the prevailing willingness of city officials to sting the contractor on occasions, the ridiculously low bidder is awarded the job. Lacking experience and an organization he is soon head over heels in a dozen kinds of grief. He throws up the job or stays on and goes broke. This makes for poor construction, delays competition, increases costs and balls things up generally. Meanwhile, the responsible bidders are looking for other jobs, occasionally winning out, of course, at a fair price, but being often thwarted by the irresponsible bidder at every letting.

"Isn't it about time for engineers to come to the rescue of contractors in this connection? For humane reasons why not save the irresponsible bidder from his ignorance and folly? He is a good man, as often as not, but is out of his element. With credit at the bank and an inclination towards contracting, and a desire to win the supposedly large profits in the business, he takes a flier in the construction business and speedily goes broke. Let engineers warn their employers against the irresponsible bidder. Let engineers explain that it never pays to under-pay a contractor. The owner invariably suffers when an attempt is made to gouge the contractor, especially a contractor who is incompetent, inexperienced and not any too strong financially"

Notwithstanding the above, 99 per cent of all contracts let are awarded to the low bidder.

Did any one of you ever hear a conversation in regard to the responsible bidder? No, sir! It is always the low man who gets talked about and bored to death with salesmen of various kinds.

We figured on a job at one time for a large corporation and were given to understand that they were not in the habit of awarding their contracts to the lowest bidder, but to the one who was capable and equipped to execute the work in the time specified. The responsibility of the contractor to receive the contract was to be determined by going into every

detail of the work with their engineers, listing up all equipment and organization to be placed on the work, and estimating the amount of time required to complete it. One can readily see that a low bidder with a one sack mixer and a few small tools, no credit or organization, would be put out at first base with these sort of umpires.

Only 5 Per Cent Survive

When a low bidder is awarded a contract at a price for which the work cannot be done, he almost invariably defaults and blames the specifications, or in most cases the decisions of the engineer in charge, for his downfall, whereas, in reality it was entirely due to the prices he made in his bid. Statistics show that 95 per cent of the contractors who start in business fail sooner or later, most of them sooner. This leaves a small margin of 5 per cent of responsible contractors to pick from, the balance of them are carpet sackers who were foremen or perhaps field superintendents for some contracting concern, or perhaps they were road supervisors who imagined after they built a small culvert for the township that they were eligible to start out as a full fledged contractor.

I once upon a time had occasion to check the bid of a certain contractor on a road job. His figures looked very low to begin with and upon going into it, I found that he had not included any reinforcing steel. When asked why he had omitted it, he informed me that on the last job he had he by mistake had ordered twice as much reinforcing steel as he needed. In other words, he had duplicated his steel order. When he finished the job in question, he found that he had realized a fair profit on the job, and had enough steel on hand to use in the next job, so did not figure any steel in the job being checked. He considered that the steel cost him nothing, and he was in a position to put in a low bid that no one could beat and make the state of Illinois a present of two or three cars of perfectly good reinforcing steel.

The state of Illinois is not responsible for the condition of a contractor's bid. I do, however, blame them if they award a contract to an irresponsible bidder. It does not seem to me that there is any excuse for it. The state is no different from the majority of owners, always being ready to take a chance on a low bid in order to save money.

If there are enough bids taken, it is certain that someone will pop up with a low bid full of mistakes and omissions and right then and there the job is awarded.

If the owners could estimate the amount of money and time a loosing contractor costs them, there would be no more irresponsible bidders given contracts. In the case of road failures, the public losses are greatest of all.

I am in favor of a clause being inserted in all specifications that would entitle the owner to have access to the contractor's detail figures on jobs where there is a question in the mind of owners as to the reliability of the contractor's figures. This, I know, will be objected to by a large majority of contractors, and will, no doubt, be called divulging their trade secrets. The state of Illinois does not want to see a contractor lose money, but of course wishes to get the work done as cheaply as possible. It seems to me that it would be much better for the contractor and state both, if the mistakes could be weeded out of the bids before a contract is let, showing the contractor where he is wrong, then turn him loose rather than award him a contract that he cannot fulfill.

The substitution of certified checks for the bidders bonds has done a great deal towards raising the standard of bidders on road work and much credit is due to Mr. Horst who presented this subject last year at this school, for he undoubtedly started the ball rolling that finally put the bidder's bonds out of business.

Careless Contractors

Owners should bear in mind that a great many contractors come up through the ranks and have had a little or no business training before entering into the contracting business at times on a large scale. These men do not believe in books or cost keeping. Many of them carry their office in their hat and depend entirely on their own judgment in preparing bids, instead of basing them on actual costs of past operations. I have seen contractors bid on road work without ever having seen the job. The state of Illinois has always been willing and ready to furnish an engineer to accompany contractors on their trips over the work, who is familiar with all the details and possible difficulties that will be encountered. These are explained to contractors provided they will take advantage of the opportunity. The trouble is that so many contractors have little or no use for an

engineer, and it is difficult to get them to place much dependence on what the engineer tells them.

With proper system of cost keeping records, it should not be necessary for a contractor to gamble. From these cost records a very accurate field cost may be arrived at, to which must be added overhead, liability insurance, plant charges, taxes, bond costs and last, but not least, profit.

Summing it all up, we can compare competitive bidding to a screen that we must all pass over and anyone over ¼ in. in diameter is rejected. Then comes the job of deciding which pebble will get the job. The only chance a real contractor has is to be thrown into the screen with a lot more big ones; then they have to increase the size of the mesh to let someone in.

Lack of Finance

The second cause for many failures is the lack of finance. If the contractor has properly prepared his bid and has sufficient price so the work can be completed and finished within the specified time, he should experience no trouble in getting all the financial backing he needs, provided this reputation is good.

The state has prepared a very complete financial statement that must be on file in Springfield when bids are submitted. From these statements the state should be able to determine very closely how a contractor stands financially, provided, they are truthfully filled in. The great trouble is there are some among our numbers who do not have the proper regard for the truth and are willing to swear to most anything to get a job. There are a great many responsible contractors in the country that do not require very careful investigation. On the other hand, there is an army of carpet sackers that do, and in view of this fact, I recommend that regardless of the information contained in the financial statements submitted that every contractor who is not known to be on a solid basis be investigated by personal interview between some persons representing the state and the contractor's bank, or clients that have been given as references. You would be surprised at the real information that can be obtained about a man by asking a few questions around his home town where everyone knows him.

I a mnot trying to create jobs for anyone, but I do believe the value of the services of a competent investigator is almost beyond estimation. This man should be able to meet people and gain their confidence.

A responsible contractor should have either money or credit in the amount of 40 per cent of the face of the contract to be undertaken. This credit or cash should be unincumbered and over and above any money necessary to finance his other work should he have any.

Contractor Paid Last

Our experience has been that the average road job shows little or no profit until the final estimate is issued and paid. Competition is so keen in the road building business that it is necessary to take the work at a small margin of profit. In preparing the contractor's monthly estimates the field engineer naturally protects himself. Self-preservation being the first law of nature, he only allows the contractor 80 per cent of the value of the work actually completed. The District Engineer's office is next to handle it, and at this point the usual 10 per cent withheld percentages are deducted together with anything else they can think of. Finally it reaches Springfield where Brother McCoy deducts the cost of empty cement sacks. Testing Engineer Clemmer has a little coming for paint or mortar color, so he takes a fall out of it. Then Superintendent Cornell of the machinery department discovers the contractor owes him for the rental of a tractor, so he gets his and by the time everyone handles it, a contractor is lucky if he has collected 60 per cent of the amount due him. This, of course, is all finally paid, but rarely ever until the final estimate is issued and all during the work the contractor must have his money invested in the job.

Lack of Organization

Third, the lack of a good organization is the cause of more or less failures. One thing in contracting is dependent on another, so going back to the beginning, if the job has been properly estimated one should have no trouble in obtaining money and with money you can always employ competent help. The woods are full of good men who are perfectly able to take hold and run a job in an economical and efficient manner if the contractor will furnish the missing link, whatever it may be.

We have employed a great many field superintendents in the past and in going through the list we find that 75 per cent

of them are ex-contractors, who have tried it at some time during their life and failed for various reasons enumerated above.

The personnel of a contractor's organization should be looked into carefully. Do they give the work their personal supervision? This is very important and works wonders on any job. Frequent visits of an executive officer of a concern does away with many delays. Questions regarding the work can be settled without delay and you will find that the work progresses smoothly and uninterruptedly.

The state should be satisfied that the man who is going to have direct charge of the work is competent and able to carry out the contract according to the plans and specifications furnished. The plant layouts of the contractor should be gone into carefully. There should be working drawings to each plant submitted so the production could be checked together with the methods of handling.

A contractor in northern Illinois constructed a combination washing, crushing and central mixing plant on a road job. I had occasion to visit this plant and check it up. It developed that the plant was in balance from delivery point of wet concrete back to the drag line bucket, which had only ½ the capacity required; hence, with an almost perfect plant that should have produced 500 ft. of road per day he had but 250 ft. due to the one mistake at the very beginning.

Another case we will mention is a job in Illinois, on which the original contractor failed, and the work was taken over by the bonding company to complete when it was barely started. Our firm took over the job. We found that the trouble the original contractor had was that he had endeavored to shovel his sand and gravel out of the cars by hand. This slowed up his operations to such an extent that he defaulted. A machine for handling this unloading could have been rented for half of the cost of shoveling by hand and would have brought up his production to a point where he would have gone through. We took over this job from the bonding company at a price enough lower than the original contract to allow the bonding company to close up with no losses and we made our figured percentage of profit.

Should any contractor present find himself in need of equipment for a job where the prices are right, I see many smiling faces among our listeners who I am sure will be more than pleased to come to your rescue with open arms.

A contractor's past experience should be carefully investigated. The owner, whoever it might be, should satisfy himself that the contractor has sufficient knowledge and experience to get through with the work on time.

This should be done by a competent investigator appointed by the state for this purpose. Letters of recommendation sometimes help, but when you wish to find out the real truth about a man sit across the table from the source of your information and you will get it straight. Letters we often give to persons simply to help them along or to get rid of them, with the full knowledge that we would not employ them ourselves.

Last, but not least, beware of the contractor who comes to Springfield two days before the lettings with his bid made out in pencil so it may be changed after he sees who his competitors are. After the arrival of every train he makes a round of the hotels to see who is registered and changes his bid accordingly. If Joe Orr is in town, he decides to raise it. If I. D. Lane shows up he lowers it, and etc. This man is not a good contractor and is guessing and should be disqualified.

The foregoing paper by Mr. Jennings was read at the Illinois Short Course in Highway Engineering, at the University of Illinois, February, 1925.

THE NECK OF THE HIGHWAY TRANSPORTATION BOTTLE

By C. C. Williams, Professor of Civil Engineering, University of Illinois, Urbana, Ill.

Just as a chain is no stronger than its weakest link, any transportation system is limited in capacity by the constriction or the essential feature of least capacity. On a certain railroad which came under the speaker's observation, for example, one terminal was the element which limited the capacity. Several railroads now are making careful surveys of their systems to locate the features that limit capacity. During the War, the capacity of the few ports from which our railway system is unfortunately suspended, limited our export capacity. So in our highway system we are likely to find a stricture somewhere that will limit capacity and usefulness of the entire sys-

tem, just as the neck of a bottle limits the rate of filling or emptying a bottle. It is probably not a new proposition to say that the city streets and city approaches constitute such a stricture in the highway transportation system; or otherwise stated, the highway terminal as is the case with the railway terminal, is the bottle neck of highway transportation.

The Constriction

The presence of such a bottle neck or stricture in the highway transportation system should be given careful consideration by highway engineers, for the system will be most efficient if consistently designed like Dr. Holmes' "one hoss shay" without a weakest part. What elements cause this constriction; are they inevitable; if avoidable, what is the most effective mode of securing relief; what significance has this circumstance on the questions of highway location strategy; how many this circumstance affect the character of transportation vehicles themselves; what new engineering devices if any may have to be invented to meet the situation; and what is the economic significance of securing perfection in this particular, are all the questions which require extended consideration, but which can not receive much more than mention at this time.

Narrow Streets

The causes of the transportation stricture in city streets are numerous. Perhaps the first to mention is a hereditary weakness namely the narrowness of the streets themselves. They remain over from a past age of low velocity transport. and are generally inadequate for modern high velocity transport. Since the capacity of the tributary highways varies with the speed that vehicles can make over them, the number of vehicles reaching a city per hour has been increased nearly in proportion to the increase in speed of vehicles over the tributary highways. Moreover, the radius of the territory tributary to a city has been greatly extended by the advent of high velocity vehicles. In addition to the larger number of entering vehicles, the number of city owned vehicles has increased enormously. For these reasons, streets adequate to accomodate the horse-drawn vehicles of a quarter of a century ago are found now to be quite inadequate. The amount of widening of streets that can be economically justified is a matter that requires careful consideration. Frequently street widening may be adopted advantageously, where the streets are obviously narrow, but street widening should not be expected to offer a panacea, because any feasible program of street widening cannot provide all the space desired.

Parked Cars

The second cause of congestion results from parked cars. Automobile drivers not only demand a right-of-way and track for their vehicles, but a terminal as well. Indeed, they demand that treminal space be provided wherever they may choose to stop. To what extent is the public under obligation in furnishing a highway to furnish a terminal for carriages at public expense is a debatable question. It seems fairly clear that the benefit of such indiscriminate parking does not inure to the public, but rather to the automobile owners, and to the business houses which are patronized by the car owners. Still, it is probably unfair to charge the entire cost of providing parking space to abutting porperty, and the administrative device for assessing the cost equitably through public channels to automobile owners is complicated, to say the least.

Highway Terminals

To what extent private parking space can be made available on a commercial basis has yet to be demonstrated. Where areas are to be found, near a business district, is an unanswered question. Will a multiple story building for parking be feasible? Such a building would necessarily be of robust construction but the simple arrangement of exterior walls, frame, floors and elevators to accomodate the business would not be elaborate and therefore not an expensive type. Such a scheme seems expensive but may not some expense for a highway terminal be justified?

Railroads have approximately as large an investment in terminals as in line facilities. While no segregation of figures has been made to date that show the exact division of investment between line and terminal, well informed opinion estimates the terminal investment on railroads only slightly if any less than line investment. Should our highway system include a terminal investment comparable to that already existing and to be made in highway lines? Perhaps the ultimate investment may be much less owing to the circumstances of the case, but the analogy is almost startling when a serious consideration of highway transportation

is proposed. Certain it is that the planning of routes is far from the total highway problem, and just as the railroad terminal has steadily increased in importance as the tranportation burden increased, so will the highway terminal situation increase in importance as the highways take on their share of the transportation burden.

At Public or Private Expense?

Will the necessary terminal facilities be furnished at public expense, or will they be provided by private enterprise under the guise of a new public utility? The same influences which now foster the iniquitous situation in which commercial bus and truck lines have practically the free use of public highways in competition with railroads and street railways may urge this further burden on the public, but it seems inevitable in the final adjustment of transportation on an economically sound and an ethically just basis, not only original construction but a proper portion of maintenance and of the cost of highway terminal facilities will be borne by the users. Administration machinery always lags behind technical achievement and it is probable that the life of our first highways will have to elapse before the principles of just apportionment of the highway transportation burden are comprehended and adequate legal machinery set up for its accomplishment.

Accessibility

Another loss which results from our present street congestion and which is not equitably borne at present is the loss of value in property due to decreased accessibility. Accessibility is one of the important elements controlling the value of city property and congested streets are seriously affecting the accessiblity and hence the value of city property in many cases. It is manifestly unfair to require business property to sustain the loss of value resulting from decreased accessibility due to congestion of traffic when that property has no part in creating such traffic. Through traffic, either cross-town or cross-country should therefore be kept off business streets and the approach streets to business districts where they have become congested.

Fast and Slow Traffic

Another element which affects the congestion of city streets and approaches is the mutual interference of different classes of traffic. Slow moving trucks, automobiles, horsedrawn traffic and bicycles are found passing down the same streets promiscuously. Delays and accidents result. Certain preferred streets are thus congested while parallel streets are comparatively empty. To what extent tradition and personal liberty can be retained in such matters as permitting horsedrawn vehicles to mingle promiscuously with high speed traffic with the consequent obstruction is a question for councils and courts to answer. Suffice it to say that the mutual interference of traffic merits careful study. The traffic on the great boulevard of Paris, the Champ Elysees, was separated into lanes of fast and slow moving traffic several years ago and yet the congestion there does not compare with that on most of our busy streets and we might properly consider the advantages of such a procedure more fully than we have.

The Author Is Not Prejudiced Against Automobiles

Without seeming to entertain a prejudice against autombiles, I should like to call attention to the inefficiency of the present private automobile as an instrument for transportation. Omitting the 2-passenger cars, several counts of the occupants of the cars on city streets as well as country highways show the capacity as about 30 per cent occupied including the driver on the average. Including the 2-passenger vehicles this proportion of occupied space is increased to about 50 per cent. This is very little better than the accomplishment of passenger trans which has averaged about 27 to 28 per cent for several years.

One of the merits claimed for highway transportation is efficiency, resulting from directness and freedom from lost motion, yet aside from the 2-passenger cars, the showing is not particularly gratifying, since it does not greatly exceed the efficiency of professedly inelastic railroad transportation. Indeed, the counts above mentioned are entirely too favorable to the automobile in the comparison, for in many cases where more than one person occupies the vehicle, the driver is in no sense a passenger but is present only as a chauffeur, and this fact would still further reduce the efficiency in passenger transportation.

The One Man Vehicle

The efficiency in transportation of the 2-passenger vehicle raises the question as to whether the very light one man vehicle, which is making its appearance in

Europe, may not have a future, and come to have considerable influence in the problem of street congestion. Such a single passenger car is somewhat more commodious than a motorcycle but smaller and perhaps less dignified than a Ford roadster. The ordinary 5 or 7-passenger automobile in size and weight exceeds the requirements of normal legal operation, being designed for high speed when fully loaded. The average operating conditions are actually about 20 miles per hour for speed and about one-third of capacity occupied, utilizing therefore only about one-third of the rated power and about one-third of the capacity. These circumstances mean that cars as now built occupy, either while in motion or while parked, space altogether out of proportion to their transportation efficiency. In other words, our streets are clogged to a great extent by empty vehicle capacity.

Sizes of Automobiles

These facts suggest the thought that at present there is not enough variation or range in sizes of private automobiles. License fees should carry a greater spread so as to encourage the smaller cars and to tend to restrict the use of large cars to circumstances where their use is warranted and in order that large cars might carry their proper proportion of highway costs, including construction and maintenance as well as terminal costs. This distribution of fees should give greater weight to the space occupied by the different cars and to capacity as well as to distance traveled annually. This last factor, viz. distance driven, is most readily measured by gasolne consumption. In this connection, and in passing, it may be said that the justice and propriety of a gasoline tax can scarcely be questioned so far as highway traffic is concerned. The fact is, a highway is a publicly owned utility and the basis of charges for the use thereof should be similar to that employed in utility rate-making generally, namely, a basic, or a "ready-to-serve" charge to cover fixed costs and a variable factor depending on the amount of use the ratepayer makes of the utility. This is a principle of ratemaking of general acceptance and is equitably applicable to highway fees. At present fees are not properly adjusted either to the fixed charge or the use charge.

Remedies Suggested

Following the preceding diagnostic remarks, something in the way of proposed remedies might be expected, although at the outset, I would disclaim having a panacea to offer.

Since much city street traffic originates in the country, an effort should be made to avoid additional congestion from such traffic. Two devices may be used to accomplish this end; viz. (a) guiding the traffic on to several streets and (b) bypassing as much through traffic as may be practicable.

Guiding traffic onto different streets may require opening up new approaches to cities. Traffic entering a city will consist of three main classes, viz. (1) that seeking the business center of the city, (2) that seeking the residential section, and (3) through traffic. Unless there are limiting or controlling points, traffic could be conveniently guided to different approaches according to destination. This procedure would correspond roughly to the function of the classification yard in the railroad terminal. Of course, where such controlling points exist as bridges over a stream along which the city is located, a separation of traffic before entering the city becomes impracticable. The remedy in such a case is obviously ample space at the entry to such a bridge or controlling feature and space with clear and conspicuous directions at the exit.

By-Passing Through Traffic

Recently the technical press has carried a discussion of the feasibility of by-passing through traffic and the advantages of this procedure are becoming more apparent as people become more acquainted with the character of highway traffic. A third of a century ago the railroads began to realize the importance of shunting through cars around large cities and their outlying classification yards are designed with this idea as a fundamental principle. Endless confusion would result if, in Chicago, for example, through cars were handled in the city yards commingled with city traffic instead of being shunted around on connecting and belt line railways. An analogous situation is beginning to prevail in handling highway traffic.

In many cases, such by-pass roads do not add to the distance to be traveled, but where they do care must be exercised in locating such by-passes in order to minimize the additional distance, for distance is an important detail in highway location.

In an interesting article by Mr. C. W. Brown, Assistant Chief Engineer, Missouri Highway Commission (Engineering News-Record, Jan. 1, 1925) and another by Mr. G. F. Schlessinger, State Highway Engineer of Ohio, (Engineering News-Record, Jan. 29, 1925) the authors describe the deliberate policy adopted by those states of by-passing the cities which lie in the line of heavy through traffic.

Against Hasty Conclusions

In seeking a solution for the problem of congested city streets, a proper sense of proportion should be retained. When we encounter narrow streets, as a serious impediment to traffic and hence to our cherished program of highway building, we are inclined to be impatient and exclaim, "Let there be room. Let the streets be widened forthwith. Cut off the ends of buildings; lay out diagonal thoroughfares; separate grades at intersections; separate the sidewalks from the street level; automobile is king; make way for the king."

I am inclined to the belief that we should observe *automobile* a while longer before we elect him absolute monarch for he may not prove to be so invincible after all. Like Saul, the auto may seem to stand head and shoulders above its fellow agents of transportation, and therefore to warrant enthronement, but inherent weaknesses and limitations may cause it to fail under stress and at a time of crisis, so that as in the case of the Son of Tish, we may yet have to elect another, perhaps even of another tribe. The results of drastic measures may not be worth the price in many instances. Of course, where streets are obviously too narrow and crooked, a program of street widening is proper, but in many cases, it is doubtful if the increased returns to property owners will justify extensive operations along this line.

A Good Word for the Trolley Car

Two factors which are fairly dicernible are likely to alter the character of street traffic of the future to a marked degree, namely, (1) the proper adjustment of fees and taxes to be borne by automobiles, which will be made possible by a more extended experience with this new transportation machine and (2) the increased cost of gasoline. The former will result from a more adequate knowledge of the function of automobile transportation as related to steam and electric railway transportation and of the cost of motor transportation including the cost of roadway and terminals. About five years ago, an editorial in an eminent technical journal, interpreting the many financial difficulties of street railways at that time, averred that electric street railways were an obsolescent agency of transportation. At that time, the argument semed fairly convincing, but subsequent history has demonstrated that the statement was erroneous. Street railways may have to pass through a period of adjustment but they are not obsolescent. Motor vehicles can not now, with all the advantages provided free by the public, care for urban traffic, and it is only a matter of time when a more equitable placement of the cost of highway and street transportation will allow street railways to assume their proper place with appropriate rewards in the general scheme of transportation.

To Save Gasoline

The probable future increase in the price of gasoline will doubtless act as another inducement to build lighter cars, which may render uneconomical much of the expensive accomodations for motor traffic which are apparently justifiable on the basis of present conditions. With motor cars designed primarily with a view to minimize gasoline consumption as is now the practice on the Continent in Europe radical changes in operating conditions will result which will materially affect highway and street policies.

The Saturation Point

In other words, when the fact is realized that the property owners are expending through fixed and maintenance costs for streets a sum that in many cases is comparable in magnitude to the operating expenses of the motor vehicle itself per vehicle-mile, the present extravagant luxury of large private cars for everyone will be brought before the bar of public opinion to justify its existence.

It is beginning to be apparent that the so-called "saturation point" of automobile ownership will not be set by the private purses of the country but rather by the public purse. So long as the private car owner can roam at will and at the speed that suits his fancy, means of purchasing more automobiles will be forthcoming, but when the public highways become clogged to the extent that the satisfactions accruing to the owner are greatly curtailed, auto sales will be limited to replacements. Thus the point of saturation wil be set by a natural economic principle of diminishing returns rather than by the

ability of the manufacturer to produce or the ability of the public to purchase. It is futile therefore to premise our highway programs on an indefinite increase in highway capacity but we must base it rather on the natural equilibrium of economic forces affecting transportation when all elements of fixed and variable costs are included.

A Timely Note of Warning

I have attempted to call attention to one important and somewhat neglected aspect of highway engineering. At the risk of being called unprogressive if not reactionary, or worse, I have sounded a conservative note, but I am convinced that the present tendency to go to almost any extreme in modifying city streets to accommodate the present high tide of automobile traffic must be more carefully investigated and that many proposed schemes requiring great outlay and the distribution of valuable property cannot be justified.

Whatever may prove to be the ultimate economies of the situation, the bottle neck of highway transportation notwithstanding all feasible measures for alleviation, is now and doubtless will continue to be the city streets and the approaches thereto. How serious this constriction will ultimately prove to be will depend upon future developments of motor vehicles and on the allocation of costs of motor transportation.

The foregoing paper by Professor Williams was presented during the Short Course in Highway Engineering at the University of Illinois, February, 1925.

POINTS TO WATCH IN WATER PURIFICATION PLANT DESIGN AND OPERATION

By Stanley T. Barker and Harry F. Ferguson, Division of Sanitary Engineering, Illinois State Department of Health, Springfield, Ill.

The rules of the Illinois State Department of Public Health require that plans for proposed new water supplies, or for changes and additions to existing supplies involving the sources of supplies or methods of handling, treating, or storing of water, be submitted to the Division of Sanitary Engineering of the Department of Public Health for review and approval. Therefore, it may be of interest to know just what points are given the most consideration when water-purification plant plans are received for such review.

Purification and Not Structural Features Reviewed

Plans are reviewed to determine the ability of plants built according to them to clarify and purify water satisfactorily and to a certain extent economically. Plans are not reviewed as to structural stability.

Knowledge of Existing Plants of Value

The detailed studies and the continuous check on the operation of existing plants in the state that have been and are being made by the Division of Sanitary Engineering, combined with certain knowledge relative to some plants in other states, the requirements of other state sanitary engineering divisions, and a review of published articles dealing with water purification give a good basis upon which to judge plans.

Improvements in Design Encouraged

Effort is made to be fair and open-minded when reviewing plans and especially toward any unusual design or new development.

If an experienced engineer incorporates in his plans some new idea which has not been tried out elsewhere and there is no experience or evidence to prove that the new feature will not work or be satisfactory the engineer is given the benefit of the doubt and the plans are approved. The engineer and community for which the plans are prepared, however, are advised that the Division of Sanitary Engineering cannot guarantee the new feature but is agreeable to seeing it tried. In this way improvements in design are encouraged and the possibility of interfering with progress in the art and knowledge of water purification is avoided.

Experienced Engineers Recommended

Plans are submitted for review by engineers of varied experience in water-purification plant design and operation. In some cases a single comment or suggestion for improvement in the plans can not be made. In other cases the engineers have been advised that the plans are so incomplete and worthless that it is not worth while trying to revise them and we advise the mto secure an engineer experienced in that kind of work to help them on the design.

Complete Plants Desirable

If the finances of a comm[illegible] are such that it can not afford a[illegible]ion plant which confor[illegible] best [illegible] every respect, [illegible]ay [illegible] vided the u[illegible] such [illegible]ions

can be made later readily and at reasonable expense. Such approval is given only after it is very evident that a more complete plant can not possibly be financed at the start and the community is advised of the shortcomings of the plant.

Data on Existing Plants

The Division of Sanitary Engineering has recently completed a tabulation giving quite detailed data on all the water-purification plants in the state, and it is from this tabulation that the following facts have been deduced:

There are at present 49 water-purification plants in actual operation and 4 under construction. There are several others proposed or ready for construction.

The largest plant is at East St. Louis, which has a nominal capacity of 27.3 million gals. per day. The plant at Evanston is second at present and even with the proposed increase in capacity to 24 million gals. per day it will still be second. The smallest plant is at Mascoutah, with a capacity of 0.12 million gals. per day and the next smallest is the 0.36-million-gal. per day plant at Warsaw.

All except 5 plants in the state have gravity filters as distinguished from pressure filters. Several other plants originally had pressure filters which were later converted to operate as gravity filters and sedimentation basins were added. Of the 5 exceptions 3 are old plants, 2 of which treat Lake Michigan water and do fairly well when the turbidity is low, while the other is used only in emergencies to treat Fox River water and operates at a very low rate. The fourth exception is the pressure filter in a water-softening plant. The fifth exception is a plant built comparatively recently and against the advice of the Division of Sanitary Engineering. This plant has been in service for 3 years and has never furnished a satisfactory water. The operating cost has been excessive and extensive and expensive changes will be required to make the plant even reasonably satisfactory.

A large majority of the plants have capacities of 1½ million gal. per day or less, 35 of the 49 being in this group and nearly all the proposed new plants will be of less than 1½ million gals. per day capacity.

There ' single-unit filter plants in the s' f th^ is in a water- ^fte. which ^rated intermittent where is not required to improve the sanitary quality of the water. The other plant handles a water that is very turbid at times and when the filter is out of service for any reason it is more or less impossible to provide a satisfactory water by the use of only alum and chlorine. Of the other plants in the state 20 have 2 filter units, 8 have 3 units and the rest have 4 or more.

More than Two Filter Units Recommended

Where a plant has to be operated nearly up to capacity, the provision of two units does not give very much flexibility and in case of any prolonged release from service of one unit, the single filter remaining in service will have to be seriously overloaded. At least 3 units, therefore, are recommended wherever considerable excess filter capacity will not be provided.

Filter Capacities

Filter capacity is computed on the basis of 2 gals. per sq. ft. of sand surface per minute (125 million gals. per acre per day.) We have found that this rate does not impose an excessive load on the filters where the sedimentation capacity is reasonably adequate and where the filters are kept in proper condition. It is possible that this rate can be exceeded with safety in plants treating Lake Michigan water (except at seasons when algae are causing trouble), but with the more polluted and more highly turbid water from the streams and reservoirs downstate, this rate should not ordinarily be exceeded, and where the preliminary treatment given the water is inadequate, the rate should be reduced

Underdrains

Underdrains have a dual function. They have to collect the water uniformly from all parts of a filter and have to distribute the wash water uniformly over the area of a filter.

With the customary type of underdrain, which comprises a large central manifold and laterals extending to the sides of the filters, it is necessary to have the sizes so proportioned that the pressure during washing is about the same at all parts of the system. This is usually accomplished by deciding on the total area of the openings in each lateral and making the area of the laterals enough times greater than this total that uniform distribution is secured along the laterals, and then by making the area of the central manifold enough times greater than

the total area of all the openings to obtain uniform distribution along the manifold. We have found that where the proportions of the laterals and manifold are not adequate that unequal distribution of wash water results.

The area of openings in the laterals should not be so small as to cause an excessive loss-of-head and on the other hand should not be so large that an unequal distribution of wash water will result if the manifolds and laterals are kept of economical size. Plans are checked on the basis of the laterals having an area about 3 times the area of the openings and the manifold having about 1½ times the area of the openings if the wash water enters the manifold at the end. An area of openings of 0.2 to 0.3 per cent of the filter area is considered satisfactory.

Gravel

The gravel depth must be sufficient to distribute the wash water uniformly before it reaches the level of the sand and the size must be adequate so that it will not be displaced by the entering wash water. Where insufficient or too small gravel is used, we expect to find unequal distribution of wash water and a tendency for the sand and gravel to become intermixed. For a high velocity wash 15 to 18 ins. of gravel ranging in size from 1½ to 2½ ins. at the bottom to ⅛ in. at the top is considered satisfactory.

Sand

Where an insufficient depth of sand or where a too large or non-uniform sand is used the filter effluents have been found less satisfactory than where an adequate depth of proper-sized sand is used. The uniformity of the sand is important also because a non-uniform sand will tend to segregate laterally as well as vertically, the finer material moving to one side of the filter while the coarse sand moves to another place because of slight inequalities in the distribution of wash water. This, of course, results in unsatisfactory bacterial efficiency.

The standard adopted for sand is that it shall have an effective size of between 0.35 and 0.45 millimeters and a uniformity coefficient of less than 1.6. Most of the well-known water filter sands on the market meet this specification and some of the natural sands can be washed and scraped to meet this specification. A sand depth of 27 to 30 ins. is considered adequate.

Wash Troughs

Wash troughs too close to the sand surface will waste sand and if too high an excessive amount of wash water will be required to clean the filters. If the spacing between troughs is too great, causing long travel of the dirty water, the washing will be inefficient and unsatisfactory. A lateral travel of 36 ins. is the maximum that should be used and 30 ins. or less is to be preferred. If the troughs are not of adequate size, they will submerge during a wash and reduce the efficiency of the wash.

The elevation of the trough crests is somewhat dependent on the size of sand used and the actual rate-of-wash available, but with a 24-in. wash a height ofcrest of 22-24 ins. is usually satisfactory. Computing trough sizes for any rate-of-wash is not simple. We have found that sizes computed by the method given in Ellm's book on water purification are usually adequate and not wastefully large.

Filter Piping

The size of the filter piping and whether the supply of wash water is adequate in quantity and pressure have to be considered together because the size of the wash-water main has a bearing on the pressure required to be furnished by the wash-water pump or tank, and the rate that the water will be used determines the size of sewer branch and mains that must be provided. We have found poorly designed plants where some one feature of the design has set a limit on the rate-of-wash that could be used and thus has influenced the plant efficiency very markedly. Practically all the new plants are reasonably satisfactory in these respects, but some of the older plants are badly handicapped by their inability to keep the filters clean and in good condition

Rate Controllers and Loss-of-Head Gages

Engineers do not ordinarily send in plans which do not provide for rate controllers and loss-of-head gages, but occasionally an engineer who is designing a small plant in which these "accessories" are an important item of cost, will bring up the point that many plants are not using their rate controllers or gages and that they are not really necessary.

The water-treatment tabulation prepared by the Division of Sanitary Engineering shows the rate controllers of about 13 of the plants are not in service and an even larger number of the plants are not using their loss-of-head gages, but while we recognize that plants can be run without these "accessories" we do feel that a consistently safer filtered

water will be produced by a plant where the rate-of-filtration is kept from being excessive by rater controllers, and where the condition of the filters is shown at all times by loss-of-head gages. Also the operation will be easier and more econominal where the controllers and gages are kept in service.

Various types of controllers are in use and we make no recommendation regarding the type to choose. All require attention, some more than others, but where a properly designed controller or gage has been installed, it appears to indicate a certain slackness on the part of the operators when these are allowed to get out of service for any length of time.

The sedimentation basins and appurtenances such as the mixing basins and coagulant feeding devices should be such as to reduce the load on the filters to a reasonable amount. There is only one plant in the state where the water is given preliminary sedimentation before the coagulant is applied, and this provision seems to be justified by the comparatively moderate chemical dosage required to treat the turbid and highly-polluted water of the Mississippi River.

The coagulating chemicals are fed in solution at all but 6 of the plants and in 3 of these 6 the alum is fed in solution, so the experience with dry-fed apparatus in this state has been rather limited. The operators at the plants which have dry-feed machines, seem to feel that they are satisfactory. This is contrary to the experience in Ohio, where the consensus of opinion of the operators was that solution feed was more reliable.

After the coagulant is fed into the water at a rate which is proportionate to the flow of raw water, and considerable thought has to be expended so that this will be possible, the next point is to see that the chemical shall be thoroughly mixed with the water so that a suitable floc will be developed by the time the water enters the sedimentation basin. Of the 53 plants in operation or under construction, 26 have mixing basins, and mixing basins are under consideration for several others. At some of the other plants the alum is added to the water on the suction side of the low-service pump which gives a fair degree of mixing but provides no contact period before the water enters the sedimentation basin.

Experience at several of the plants where mixing basins have been used and abandoned and then used again shows conclusively that a mixing basin is worth while even where the retention provided is small, if only the agitation secured in the basin is adequate, and we, therefore, require that all new plans make provision for mixing basins.

The retention periods in the mixing basins now in service range from 0.2 to 40 minutes and the velocities developed by the baffles range from 2 to 80 ft. per minute. Of course, the mixing basin in which the velocity is only 2 ft. per minute is useless for mixing and really serves only as an extension to the sedimentation basin.

For new plants we usually require that the retention periods be at least 10 to 20 minutes and the velocities developed shall be 30 ft. per minute or more Experiments by the U. S. Public Health Service have shown that it may take 20 minutes or more for floc to form where a minimum alum dose is being applied, and other experimenters have shown that the best mix is secured when the velocity is from 40-60 ft. per minute and the basin is baffled so that the flow is reversed as abruptly and frequently as possible. Therefore, we feel that our requirements are not unreasonable and we believe that a plant where an adequate mix is provided will show a considerable saving in amount of chemicals used over one where mixing is not arranged for. Smaller mixing basins using paddles or other mechanical agitators may be used.

The principle of the sedimentation basin is, of course, rather simple in that it is merely a place where the velocity of the water is slowed down to a point where the matter in suspension will have an opportunity to settle out before the water leaves the basins. It has been shown mathematically and theoretically that the efficiency of a basin depends merely upon its area and that the depth has no bearing, but practical considerations prevent the use of large shallow basins, or the use of a number of horizontal baffles in a deep basin which has been proposed. It has been found that 10 to 12 ft. is about as shallow as the average basin can be made economically because a certain allowance has to be made for the accumulation of sediment. Most of the basins, except in the very largest plants, are about this deep.

Another feature that is both theoretically and practically desirable is that the course of the water through the basin shall be straight, with no turns to cause eddies and dead spaces. This channel

in open basins must not be too wide or eddy currens will be developed by wind action and these will interfere with sedimentation. Wherever it is impracticable to design the basins with astraight course for the water, effort should be made to limit the turns and dead spaces to keep down the formation of eddies as much as possible.

The details for inlets and outlets and for passing the water from one basin to another in the case of two basin plants, should be such as to reduce eddies to a minimum and prevent unequal distribution of water across the cross-sectional areas of the basin.

The question as to how much retention to provide is dependent on the type of raw water to be treated and the amount of money the city can afford. The original filter plants did fairly good work without any or with limited sedimentation basins, but at a tremendous cost for chemicals and wash water. Although a certain amount of sedimentation capacity must be considered as necessary to reduce the load on the filters to a point where they will yield a safe water, the exact amount is rather an economic problem of how much the city can afford to spend to obtain a certain decrease in operation cost.

The retention provided in the various plants ranges from 0 to 18 hours and the average seems to be about 4 hours. We have come to feel that 4 hours is about the minimum retention that should be provided for a plant to handle the heavy turbidity from the Illinois clay soils, but when water from very large reservoirs or from Lake Michigan is to be treated, it may be safe to reduce the retention although the algae in the lake and reservoir water frequently make large sedimentation capacity desirable.

After the amount of retention has been decided on, it is necessary to determine whether to divide the retention between two basins or to use just one, depending on the mixing basin alone while the single sedimentation basin is out of service for cleaning. Two basins are preferable, especially if the plant has to be operated continuously and nearly up to capacity, but if considerable excess filter capacity is provided and the amount of money available is limited, it may be satisfactory to provide a single basin at the start.

Clear-Water Storage

When only limited clear-water storage is provided, the rate-of-filtration has to be varied frequently to keep up with the consumption. This is undesirable and we believe that sufficient storage should be provided so that the rate-of-filtration can be kept constant for considerable periods. It is also necessary to supply storage sufficient for adequate fire protection, and we feel that we can not give unqualified approval of any plans which do not provide the storage called for by the National Board of Fire Underwriters. In some cases piping arrangements have have been made which will permit of pumping raw water into the mains in the case of large fires, but such connections have been the cause of much sickness in the past and we can not regard them as satisfactory substitutes for adequate filtered-water storage.

The foregoing points are among the most important ones that are considered in reviewing filter-plant plans. There are other minor points which are checked but which need not be included in this rather general paper.

The foregoing paper by Messrs. Barker and Ferguson was presented at the 1924 meeting of the Illinois section of the American Water Works Association.

DEVELOPMENTS IN CONSTRUCTING AND MAINTAINING CEMENT CONCRETE PAVEMENTS

By Leon V. Belknap, County Engineer, Oakland County, Pontiac, Mich.

There has been considerable development in the past few years in the methods of consructing and maintaining cement concrete pavements. This has been due to a process of evolution in several directions. First, an ever increasing demand for this type of road surface as manifested by the mileage built each year. Second, the cost of construction and maintenance of highways are problems in which the public are vitally interested. Third, a decided improvement in the design and construction of road building equipment. Fourth, the design of cement concrete pavements has been undergoing changes in an attempt not only to build a more balanced structure but also to provide more economy in its construction. Fifth, specifications have become more rigid in some respects and the results show a decided improvement. As improved methods are obtained in the handling of materials, then good pavements can be built cheaper and more mileage is the result.

Construction Methods

The methods involved are primarily a contractor's problem. His success financially depends upon the time spent in analyzing every item of the proposed work and the skill by which he assembles the units of his organization into a smooth working whole. Such problems as the source of materials, transportation, plant layout, water supply, gradients, soils, handling of materials, local labor supply and wages, time limit of contract, equipment, capital investments, etc. must be carefully considered to insure success. He estimates the cost of building a proposed highway after having carefully considered each item and adds a reasonable profit for the work. A contractor who bids on highway work and uses for a basis of his bid what other road work sold for is in a measure guessing instead of analyzing all the features connected with the new work. He, however, should build in such a manner that a demand for his services is created. His reputation for skill, reliability and integrity will not be judged entirely by how much profit he received from his work but how well the work was performed.

Contracting is perhaps more highly competitive than the manufacturing business and the manufacturer of road building equipment must remember that the ultimate test of his equipment is its final cost. That the manufacturers are keeping pace with progress in road building was evidenced at a recent machinery exhibition. Refinements of construction to insure long life, dependability and economical operation were apparent. Heavy duty units with enclosed bearings, force feed oiling systems and ease of inspection and repair of vital parts were very noticeable. Tractor equipment with increased horsepower for heavy duty machines in order to make this class of equipment more mobile for highway purposes as well as lighter equipment designed for tractor operation and a preponderance of gasoline driven machinery over steam were very evident, thus showing a tendency to supplant methods in use heretofore. Improved machinery has a large part to play in successful road building operations.

To say that one particular method is more successful than another in the construction of cement concrete pavements is rather a broad assertion. Each concrete roads but to canvas to some extent by itself and should be so analyzed. Methods that work to good advantage on one job may be entirely inadequate on another. It is not the purpose of this paper to divulge any so-called "best methods" in the construction of cement concrete roads but to canvass to some extent the various methods in use.

Subgrade

The building of a proper subgrade for hard surface pavements requires considerable care in the manipulation of earthwork. In general the earth grade is first brought to a flat section with ditches roughed out and the width of grade possibly 6 in. wider than the finished section. The flat subgrade is then channelled to the required depth and the fine grading completed. If the plans call for a layer of granular or porous material to be placed on the subgrade where a clay soil exists then proper provisions must be made in grading to allow for the addition of this material so as to conform to the subgrade elevation. Many contractors seem to grade only for the pavement section and complete the shoulders and ditches after the pavement is completed. This latter method requires considerable end movement of earth and does not permit of the proper balancing of earthwork at the time of grading.

Slips and fresnoes are still useful equipment for short hauls up to approximately 300 ft. Hauls up to 700 ft. are usually best accomplished by use of wheeled scrapers and longer hauls by wagons or trucks, loaded by means of an elevating grader pulled by a "caterpillar" tractor, or by steam shovels. The steam shovel is in more common use in Michigan, and with trucks or teams and wagons overlaps the wheeler hauls, especially when large quantities of earthwork are involved. Gasoline tractors are used for hauling straight blade graders, scarifying, rooting, plowing and the loading and hauling of four wheeled scrapers and otherwise displacing teams for this work to some extent.

Special emphasis should be made in preparing the subgrade in such a manner as to provide as uniform a support for the pavement as possible. All springy spots should be properly drained and refilled with dry material. The hard surfaces of old road beds should be plowed to a depth of 6 in. and then compacted.

Machinery has supplanted the pick and shovel gangs in fine grading to a large extent. Although there is still need for hand labor for final cleaning up, the heavy part of the work can be accomplished by machinery. Gasoline tractors of the crawler type attached to a heavy

blade grader and scarifier will remove the bulk of the earth in the channel. After forms are set a subgrade machine riding on the forms will cut the exact crown of the road bed. A gasloine roller pulls the subgrade machine and compacts the subgrade at the same time. The subgrade is finally checked by a template. Nails, driven in the bottom edge of the template to the crown of the subgrade, as the template moves along the side forms indicate by scratches the high spots.

Forms

The use of wooden side forms was permitted a few years ago but since smoother pavements and better alignments are required this type of form has been eliminated. The use of subgrades and heavy finishing machines has required more rigid forms with proper foundation support. In some soils it may become necessary to increase the bearing support of the forms by the addition of short pieces of lumber. Heavy equipment may cause the forms to sink and thereby reduce the thickness of the pavement appreciably as well as producing a wavy surface. Too much care cannot be taken in this regard if smooth pavements are to be obtained. A rough surface which is often blamed on uneven aggregate and improper mixing may be traceable to a lack of proper forms and the alignment and bearing for them. The new pavement section with thickened edge has required the use of side forms 9 in. deep.

Proportioning of Materials

The gravel of raw material, sand, gravel or crushed stone and cement are usually supplied through railroad transportation from some distant point. The problem of unloading cars and proportioning materials is interwoven with the method of mixing operations. The latter consists of several methods, first a central proportioning plant; second, a central mixing plant or a modification of it, and third, the wheelbarrow method. The wheelbarrow method of proportioning aggregates was used almost entirely a few years ago. The measuring of materials was done by gauging the load on the wheelbarrows and then dumping into the skip of the mixer. The number of loads of each aggregate were counted to get the correct amount in each batch. Later batch boxes were used on belt conveyors, which conveyed the material to the mixer. This method has been largely discontinued because of the increased cost of labor and loss of material on the subgrade as well as objection to dirty aggregate, which was occasionally delivered to the mixer. Proportioning of material at a central plant is a later development. Coarse and fine aggregate are unloaded from cars by means of a clam with ¾ to 1 yd. buckets and loaded into elevated bins. These bins are provided with measuring boxes so that proper proportions can be delivered to the hauling equipment. Where drop bottom railroad cars are obtained, a bucket elevator is sometimes used to good advantage. Occasionally contractors devise other means of unloading cars and loading trucks or batch boxes. "Set ups" have been observed where material from drop bottom cars was unloaded into bins built under railroad trestles. Tunnels are frequently used which provide for easy access by trucks or industrial cars under stock piles. Measuring boxes are provided in each case. Cement is shipped in sacks and requires separate storage at a convenient point where it can readily be placed on trucks or in batch boxes. Bulk cement might be handled to a greater advantage with a central mixing plant or proportioned by weight and deposited in separate compartments of batch boxes. It has been discovered that the volume of sand is affected by the moisture content and in some cases compensation is made on account of this by altering the capacity of the measuring box. A central mixing plant simply consists of rearranging the proportioning plant so as to discharge into a mixer and the wet batch hauled on to the road. Modifications of this layout according to the contractor's idea of arrangement have been made. Stock piles have been placed at various intervals along the highway and the mixer moved from stock pile to stock pile with the wet batches then hauled to the road.

Transportation of Materials

There are in general two methods of hauling materials to the mixer located on the subgrade. First, hauls made by a truck over the subgrade. Second, hauls made by industrial equipment, or a combination of both methods. The adaptability of the above methods seems to vary with the whim of the ocntractor where either might apply. Industrial haulage by means of gasoline locomotive cars and light narrow gauge track is confined to minimum grades and the amount of material that can be hauled by each train is limited by the maximum grade over which it is hauled. Batch boxes, two in number for each car, are loaded at the

proportioning plant, hauled to the mixer and have either bottom or side dumps or are tilted when unloaded. The tracks are usually placed on the shoulder of the road with convenient switches and at least one switch placed near the mixer so as to delay mixing operations as little as possible. If the mixer works away from the source of supply then advantage may be taken of the finished portion of the pavement by placing the track on the pavement.

Trucks hauling materials to the mixer are in quite common use. These vary from the heavy 5-ton truck to light truck with pneumatic tires. Heavy trucks are used more frequently in hauling material to a central stock pile rather than to a mixer because of damage to the subgrade, which may require additional fine grading. In general trucks can be used on steeper grades than industrial equipment and where soil conditions permit are more mobile and can take advantage of side roads where it would not pay to be continually changing industrial track. Often times heavy trucks are used to haul material from a proportioning plant over a road where railroad crossings, grades or other conditions prohibit industrial tracks and in this case where combined with industrial equipment flat deck trucks are used to carry batch boxes, and are in turn transferred from the truck to industrial cars by means of a derrick or other apparatus. Turntables are provided for turning trucks around on the grade and inside of the forms. Plans are occasionally used near the mixer to protect the subgrade and require moving as the work progresses.

Mixer Operations

Mixers are now being operated by gasoline engines quite universally due to availability of gasoline supply and reliability of motors. The size of mixers vary somewhat although the general type is of 21 cu. ft. capacity of wet mix. The mixers are equipped with timing devices so that the required number of turns are obtained automatically. Crane devices operated by mixer engines are used to lift batch boxes from industrial cars and then dump them into the skip. The crawler type of traction for mixers is coming more into use because of the greater ease of portability. Boom and buckets have replaced the spout delivery of mixed concrete. Reinforcing wire mesh or bars are held in position while placing concrete by means of steel forms, which forms are hauled along the subgrade after depositing of concrete by the mixer or reinforcing is held in place by bar chains. The use of longitudinal center joints has required the use of installing devices, which in addition to pins, hold the joint vertically in place. Care must be used in depositing concrete so as to load the center joint equally on both sides.

The method of installing transverse expansion joints vary somewhat in different localities. The use of a plank cut to crown of subgrade against which the joint material is placed, requires the refilling of space after the plank is withdrawn and results in the joint material getting out of line either vertically or transversely across the pavement. A better installing device consists of a steel plate with "V" notches cut in the bottom so that the fresh concrete supports the joint on either side and when the form is withdrawn does not alter the position of joint filler and requires a minimum of additional concrete.

Finishing of Concrete

There are several types of finishing machines on the market, which make it possible to finish concrete of a stiffer mix than was possible before. The machines are propelled by gasoline power and ride on the steel side forms. Automatic striking of concrete to the required crown, the tamping of concrete and the belting of the surface for final finish are possible in one operation, although several trips of the finishing machine are generally required to give a good surface. Hand belting methods are not entirely discarded as a good many localities use this method in addition to the finishing machine operations. Hand floats for finishing joints as well as other concrete surfaces are in use also. There is on the market a hand belting machine, which is propelled by one man and gives the final belting of the concrete. This machine rides on the forms similar to the finishing machine. Longitudinal strikes or floats are used in some states to help in eliminating waves in the surface and are operated by hand from portable bridges.

Concrete pavements are now being checked by 10 ft. straight edges, which require the surface to be not more than ¼ in. variation from a smooth surface. Hand tools for rounding the edges of the slab to ½ in. radius are required.

Curing

The methods used in curing consist of first covering the surface with burlap

as soon as the pavement has hardened sufficiently so as not to injure the concrete and then kept wet until the following day. A machine has been developed that carries the roller burlap on a circular steel drum and can be rolled off the drum and on to the pavement or vice versa. The second day, the road is covered with earth to a depth of at least 2 ins. or with straw to a depth of at least 3 ins. and kept wet for a period of 14 days.

A later development in the curing of concrete is by the use of calcium chloride. This material is manufactured in flakes or granular particles and is shipped in 100 lb. sacks or 350 lb. drums. It can either be spread on the pavement by hand with shovels and broomed or placed with a special chloride spreader operated by one man. The quantity placed per square yard varies from 2 to 4 lbs. It is usually placed on the concrete from 12 to 24 hours after the pavement is laid. The use of chloride during the season of the year when the temperature of the atmosphere is lower, around 40 deg., requires the application to be delayed a sufficient length of time, depending upon the speed of setting of the concrete, which may delay covering with chloride for 36 hours. The calcium chloride method eliminates the labor of covering and uncovering pavements with earth and the quantity of water and labor necessary to sprinkle pavement for a period of 14 days.

Contractors are required to bush hammer or otherwise remove high spots in the concrete, which exceed ¼ in. when tested with a 10 ft. straight edge. There has been several attempts at devising some mechanical means of performing this work. Stone chisels operated by an air compressor to remove the excess surface and then rubbed down with a "brick" still does not provide anything but a slow tedious job. An ingenious device has been designed by an enterprising contractor in which he used a "Fordson" tractor with an attachment supporting a vertical shaft at the lower end of which is a circular carborundum stone. This stone is caused to rotate by means of a belt from the tractor and the grinder is easily moved around over the surface of the concrete to be reduced.

Maintenance

Cement concrete pavements, like other highway surfaces, have not as yet reached the stage of perfection that maintenance may be entirely eliminated. It is safe to say that a well designed and constructed pavement of this type requires as little maintenance as any other type of road surface. The other types of cement concrete pavement, which were either laid of a thickness inadequate for present day traffic or without the advantage of reasearch in the matter of design, requires an amount of maintenance in excess of that found necessary in a well built pavement. Frost action, poor drainage, improperly constructed subgrade and lack of maintenance at the proper time are some of the causes of failure in pavement slabs. The inclined position of joint material has caused one slab to climb higher than the adjacent slab due to expansion and in which position impact from heavily loaded vehicles causes the gradual destruction of the section and shows carelessness in construction. The placing of pavement on newly graded roads, especially where heavy cuts and fills are made and proper settlement of earth has not taken place has also tended to increase the cost of maintenance. Where the minimum width of pavement has been increased from 16 to 20 ft. there has been a decided reduction in the number of failures due to corner breaks and progressive failure of slabs. The increased width has permitted heavy trucks to travel at a greater distance from the edge of the pavement slab and is therefore less liable to do damage. Smoother surfaces have reduced the impact from heavy truck loads as well as a greater use of pneumatic tire equipment for the intermediate size of trucks. Increased motor vehicle travel near our large industrial centers has required the widening of some of the main arteries; yet there are and will be for some time to come, many pavements of 16 and 18 ft. in width, which are carrying an excessive amount of travel, and should be widened at this time. These pavements demand considerable maintenance and may fail faster than like pavements in less congested centers. In comparing cost of maintenance of various types of pavements, the amount and character of the traffic should be considered as well as other conditions surrounding its construction.

The maintenance of cement concrete pavements as different from gravel or other types of road surface has developed a "gang system" of repair similar to section hands on the railroad. These gangs are equipped with light pneumatic tired trucks for ease in moving from place to

place along the highway. Their job is to patrol the pavements, giving whatever attention is necessary at the proper time. Aside from the work required to keep weeds cut and shoulders properly repaired, the principal work necessary is to tar all cracks and joints so as to eliminate spalling and protect the subgrade from any undue moisture, and the patching of broken places in the slab.

Patching Concrete

In patching concrete the broken section of the pavement must be removed and the edges of the adjoining slab squared up so as to permit of a good bond. A little care in removing the old concrete so that few radial cracks remain is quite essential. If the patch is cut in such a manner as to give a reasonable area for transmitting of load to subgrade as well as eliminating all acute angles where bonded to the old pavement, the patch will remain a permanent part of the pavement. The excavation for the patch should be at least an inch deeper than the original slab. An air compressor mounted on truck or trailer and of sufficient capacity for operating at least two concrete breakers for reducing the broken pieces of the old slab and trimming up the adjoining edges, saves considerable time and labor over the old hand method of hammer and chisel. Where a considerable amount of concrete is to be broken out, some form of drop hammer mounted on a truck may work to better advantage. The old concrete can be broken up and removed by either of the above methods a good deal faster and a sufficient amount can be removed in a few hours to keep a gang patching all day. Side forms should be placed and securely staked to a depth at least equal to the old pavement. Materials, sand, gravel and cement, are deposited by means of trucks on one side of the pavement near the patch. A portable mixer of 7 cu. ft. capacity, with roller bearings and rubber tires, usually works to good advantage in the ordinary patching work. It does not take up very much space on the roadway and is easily moved from patch to patch by a small truck. The aggregate is wheeled to the mixer in wheelbarrows. Water is supplied in barrels or tank wagons filled at some convenient point. A central mixing plant if convenient to the work is sometimes used so as not to obstruct traffic. It being necessary on most concrete roads to patch only one side of the pavement at a time and to leave some distance between patches so far as to facilitate the movement of traffic. The patch should be struck off and finshed to a smooth surface with the adjoining slab as consistent with good practice in original construction.

Calcium chloride dissolved in the mixing water is quite desirable in the patching of pavement. Two to 4 per cent of this material by weight is found to be the correct proportion, the variation in amount depending on the temperature of the atmosphere. Patches heretofore which were kept closed for 21 days can be opened within a week without damage to the concrete. This represents quite a saving in watchman service, broken lanterns and barricades. The recent development of aluminate cement in this country may further reduce the cost to traffic in delays and accident hazards, where used in patching, as this cement sets in 24 hours.

Tarring Cracks and Joints

The small portable tar kettle of a capacity sufficient to hold at least two barrels of tar, with hand pouring pots, brooms and sufficient sand to cover the fresh tar, are some of the requisites of this part of the work. Barrels of tar may be distributed along the highway as well as small piles of sand. A good combination for tarring cracks consists of a truck loaded with sand, which pulls a tar kettle slowly along as the work progresses. One man sweeps out all the dirt from the cracks while a second man pours the joints and the third man covers the fresh tar with sand so that it does not pick up with wheel traffic.

A later development in the method of handling tar consists of a stationary tank sufficient to hold 15 to 20 thousand gallons in a central yard where tar may be handled in tank car lots by means of a pump and steam heat. The tar can be preheated before the gang starts out on the road so as to avoid delay in commencing operations. A portable tank sufficient to hold the day's requirements may then be carried on the truck or trailer. There is a considerable saving in the cost of tar as well as time lost in the handling of tar in barrels by this method. Asphalt may be used with success instead of tar from the pouring of cracks and joints although the writer has had very little experience with this material. There would be very little difference in the method of handling either material.

In conclusion, it has been shown that

the construction and maintenance of cement concrete pavements have resulted in an increased use of motor traction and power equipment. This has been due in a great measure to the manufacturer, who has made wonderful progress in the designing and construction of machinery to supplant man power and the perfection of that machinery so as to insure long life, dependability and economical operation. The contractors in turn have perfected organizations, the nucleus of which at least are carried on the payroll the year around, to an extent that production can be carried out with a minimum of direction.

The necessary skilled labor for work of this character is more plentiful due to an increasing amount of road work being carried on and new hands learning the trade. The successful contractor takes better care of his equipment, maintains yards and repair shops, so that first class equipment furnishes better work at less cost and delay; and makes workable methods that reduces hand power and team power to a minimum, and otherwise guarantees a satisfactory season's performance.

The foregoing paper by Mr. Belknap was presented at the 1925 Road School at the University of Michigan, Ann Arbor.

ECONOMICS AS APPLIED TO ENGINEERING PROJECTS

By C. A. Morse, Chief Engineer, Chicago, Rock Island & Pacific Railway Co., La Salle St. Sta., Chicago, Ill.

[Editor's Note: The following paper is published in line with our policy to tell "both sides of the story." While Mr. Morse's views are quite at variance, on many points, with those held by the editor, we are glad to place this discussion before our readers. Whether we agree with him or not we can admire his straightforward expression of opinion.]

The angle of engineering that I am going to talk about, I will have to admit, is not a very popular one at the present time with some of our engineers. At the annual meeting of the Western Society of Engineers last June, I discussed the matter from this same angle and it was very noticeable that when I got through there was no applause for a minute or two at least, showing its lack of popularity; but I am going to talk to you along the same line, as I believe it is a live subject at this time.

It is a favorite theory of mine that the engineer should be an Economist, and that in his discussion and in his reports on engineering subjects he should dwell on the economics of the proposition as well as on the purely scientific question of design and construction.

Unfortunately, the great majority of engineers the employed on a salary and their employment is more or less intermittent. The result of this has been that the engineer is more apt to be looking for a job regardless of the economic value of the proposition on which he might be employed. I must admit that bread and butter is the first thing that any man must look out for, and, therefore, it is not to be wondered at that a man favors the carrying out of a piece of work which will give him employment regardless of whether or not the construction of this work is to the best interests of the public at large, or to any particular community.

This country has not yet entirely recovered from the inflation that came with the world's war; the result being that we are still spending money recklessly all over the country. Fortunately we have a President of the United States today, who looks at matters from an economic standpoint, and who is endeavoring to curb the reckless expenditure of money that started during the inflated times when salaried men and laboring men were getting more money than they ever expected to get in their lives, and when people with money were making money more rapidly than they ever dreamed was possible. But while the President is attempting this in connection with national affairs, we have not yet developed people in the various states who are inclined to do the same thing in civic affairs. The result is that, today, the bane of this country is the high taxes; and we have men in high positions in some of our states who are making political capital out of the fact that they are advocating a reckless expenditure of public money. The development of the automobile, together with the motor truck and motor bus, has made every man or company who owns any of these various motor-driven vehicles an advocate of so-called "good roads"; and with the majority of the families in the different communities owning automobiles and enjoying the pleasure of riding through the country, it is not strange that they should be ready to cast their votes for the man who will favor the construction of additional hard-

surfaced roads. Unfortunately, a large percentage of the people owning automobiles are not tax payers, or are taxpayers to the extent only of paying taxes on their automobiles, therefore, they are ready to vote for bond issues whenever the opportunity is presented, providing such bond issues are for the purpose of constructing additional hard-surfaced roads.

Real estate, and the improvements thereon, are the sources from which the taxes, which are levied for public improvements, are mainly collected, and it is therefore the owners of real estate—improved and unimproved—that are suffering from the inflation of the tax-rolls during this period of indiscriminate voting of bonds for public improvements. The result is that the farmer, the town and city home-owner and businessman, and the railroads are the people who are the principal sufferers from such extravagant expenditures; but, unfortunately, they do not make up the majority of voters in many sections of the country.

As an example of the increase in taxes in the past ten years: The taxes paid by the Rock Island Railway for the year 1914 in the state of Iowa were $760,079.04 and the amount paid for special assessments was $32,274.90; for the year 1923—the last figures I have at hand—taxes were $1,363,846.52 and special assessments $82,294.30. This shows an increase in general taxes of 79.4 per cent and for special assessments of 155 per cent.

If we figure the purchasing power of the dollar today as 66 2/3 cents as compared with 100 cents in 1914, the taxes that would have to be levied to get the same value in purchasing power in 1923 as 1914 would be increased 50 per cent. It will be noted that after taking into account the difference in the value of the dollar, the taxes and special assessments of the Rock Island Railway in the state of Iowa were increased 32.5 per cent.

The farmers and landowners of the state had a similar increase in their rates of taxes, with the exception of the special assessments for the separation of grades between railroads and public roads, or an increase of 29.4 per cent in their taxes.

This increase of 29.4 per cent in the taxes of the propertyholders represents the extravagant expenditure of money on the part of public authorities the greater proportion of which has been due to the wild scramble for good roads.

A portion of this expenditure is warranted, as for instance, the improvement of roads for the use of the farmer, thereby reducing the cost of transporting the products of the farm to the market; but the larger proportion of this expenditure has been for roads for the benefit of the pleasure seeker, and many of these roads have been built parallel with the railroads, oftentimes right alongside of them, where they were of no benefit whatever to the farmer in getting his product to market; but on the other hand they have resulted in the promotion of the motor bus lines and the motor truck lines which are running in competition with the steam railroads and electric lines, with the landowners and the railroads furnishing the roadway over which they travel.

The construction of these roads is in the hands of engineers, and the point I want to make is that engineers, in reporting on projects of additional hard-surfaced roads, should make a study of the economics of the questions and see whether or not the community which has to pay the interest, and eventually the face value of these bonds, will receive a benefit that will be equal to what they have to pay for these roads.

As I travel over the country I am impressed continually by the lack of economy displayed by the people in charge of the construction of these hard-surfaced roads. Apparently, nothing is ever considered except so-called "permanent work," in the nature of concrete boxes and culverts, and concrete and steel bridges. To one who has been employed for the past forty years in the construction of railroads in the Western country, where any expenditure for an improvement had to be considered thoroughly as to the economic results of such expenditure, and who has found from actual comparison of figures that wooden bridges and wooden culverts were cheaper in many cases than the so-called "permanent work," it seems strange that no consideration should be given to such matters in the construction of good roads.

Today, all interest seems to be concentrated in the *construction* of additional roads; but the day is not far distant when consideration must be given to the *maintenance* of these roads, and when this period is reached it will be found by many communities that the maintenance of the hard-surfaced road is going to mean practically the renewal of the running surface. I understand that in Minnesota, where their good roads are

largely gravel surfaced, it is today taking all of the road tax to keep up the maintenance of what roads they have completed up to the present time. While the national government is, by strenuous efforts, making a reduction of in the neighborhood of 25 per cent in the federal taxes, our states, counties, towns and cities are making, as an offset to this, increases of from 30 per cent to 50 per cent in the local taxes.

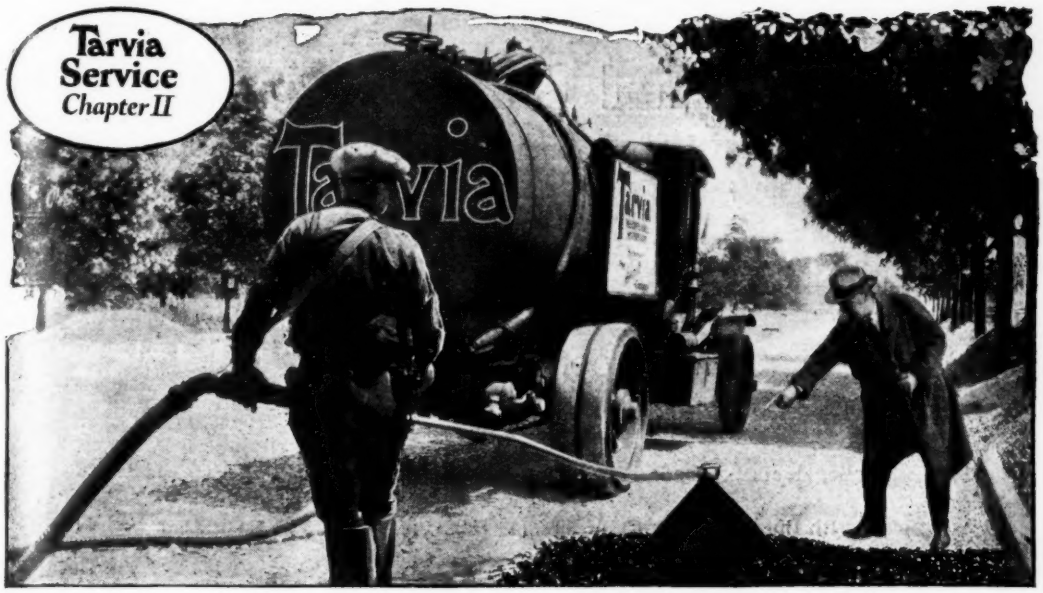
There is another angle to this; and that is, the question of when public improvements should be made. General business fluctuates from time to time, with the result that there are periods when there is a large amount of unemployment and in the spending of money for public improvements it would seem that it would be wise to give consideration to this economic fact and to plan, if possible, to make public improvements wherein public money is expended at a time when the general business of the country is depressed, thus insuring steady employment to the laboring man and at the same time cutting out the competition for labor and material during the flush times which increases the cost of all work, not only the public improvement work but the improvement work that is being done by individuals and corporations.

Having been employed by railroad companies all of my life, I naturally look at the transportation side of this question. The question of transportation is at the present time in a state of transformation, due to the development of the motor-driven vehicle, and the final adjustment of this matter is being delayed, due to the fact that, at the present time, motor-bus lines and motor-truck lines are being operated in competition with the steam and electric railways over hard-surfaced highways, which have been paid for by the general public, and which must be maintained by the general public. Eventually, the public will wake up to the fact that they are contributing a large amount to the motor-bus and motor-truck companies in the way of furnishing them roadway facilities, while at the same time paying rates to the motor-bus and motor-truck companies for transportation as great, if not greater than they have heretofore paid to the railroads, who furnish their own roadway. And when they realize this fact there will be a movement to charge a rental to motor-bus and motor-truck companies to cover the interest and upkeep on the proportion of the cost and maintenance of hard-surfaced roads affected by the motor-bus and motor-truck lines. There is a danger, however, that the public may not awaken to the point where they realize this until this competition furnished under false premises has caused the steam railways to take up many of their short branch lines and many electric railways to be abandoned; and when it is too late and these lines have disappeared the public may have cause to realize that they have destroyed the transportation agency that furnished them year in and year out and month in and month out, during all kinds of weather conditions, a means of transportation for people and for goods that was dependable and which was actually cheaper than the substitute transportation they have temporarily patronized. It is for this reason, as well as others, that I want to impress upon the engineers of the country the importance of studying questions in connection with public improvements with the same care and diligence that such questions in connection with railroads and public utilities are studied by the engineers and managers of privately owned properties.

For some reason, which none of us are able to explain, no one seems to feel the same responsibility when handling public money that they feel when handling private money. The most they seem to have in mind is getting the money, and when they have gotten it, they spend it without regard to the ultimate good of the community which furnishes it.

Some of our public officials, in their endeavor to secure money for public improvements without any analysis of the economies in connection therewith, try to convey the idea that they are more far-sighted than the general public, and that such expenditures are required in connection with the proper development of the community in the future. In my opinion, this is, in 99 per cent of the cases, simply a subterfuge which they put up as a smoke screen to hide the actual reason, which is the desire to have money to spend during their administration of public affairs. There is no legitimate reason why there should not be a study of the economics of such expenditures and the benefit stated in dollars and cents, rather than in generalities.

(Concluded in March issue)



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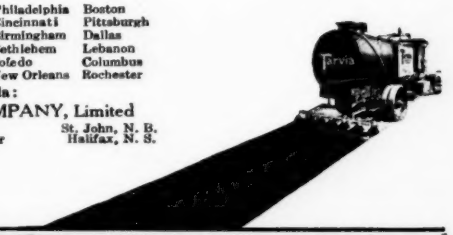
Tarvia
For Road Construction Repair and Maintenance